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MECHANICAL ENGINEERING

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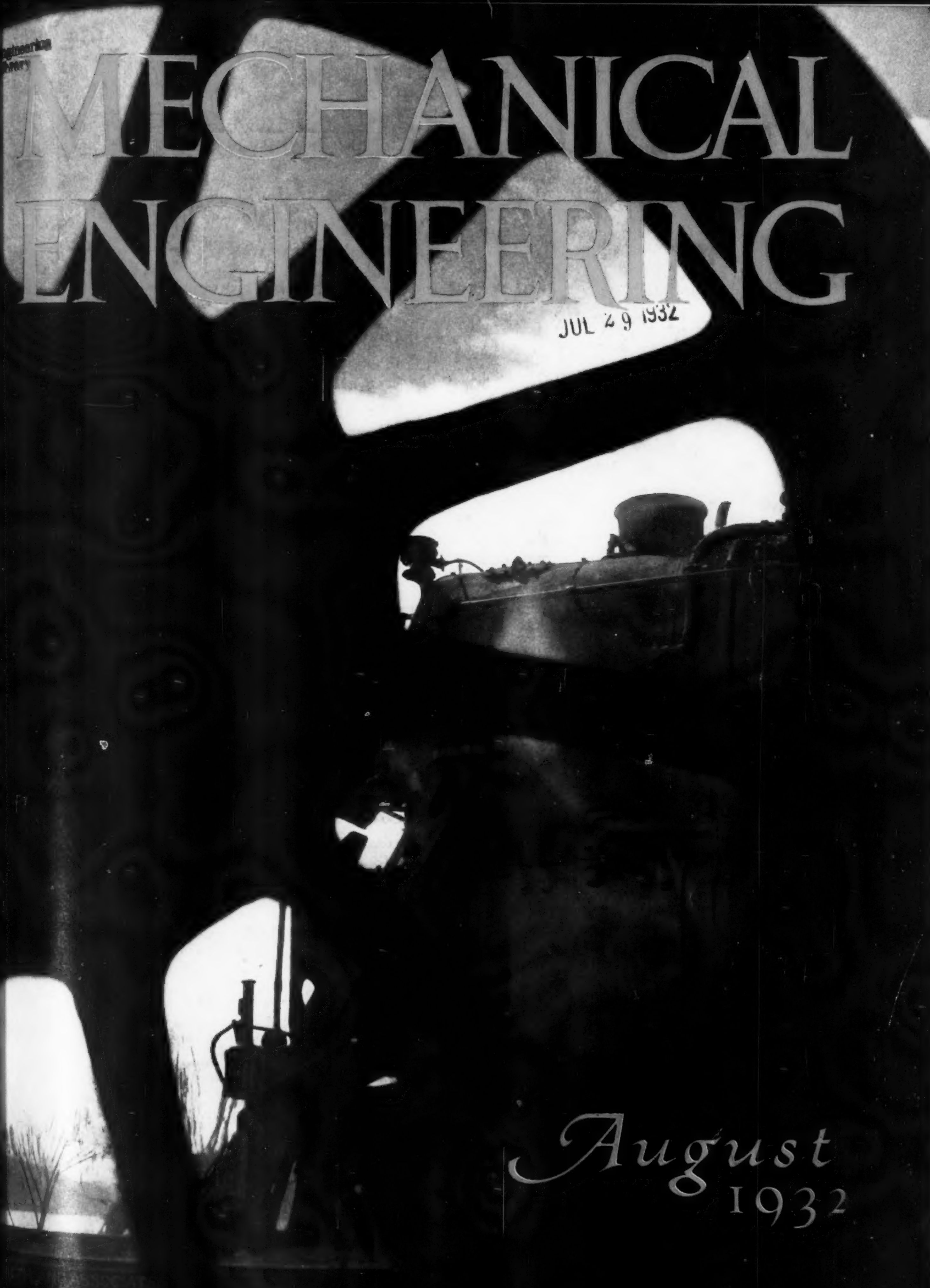

August
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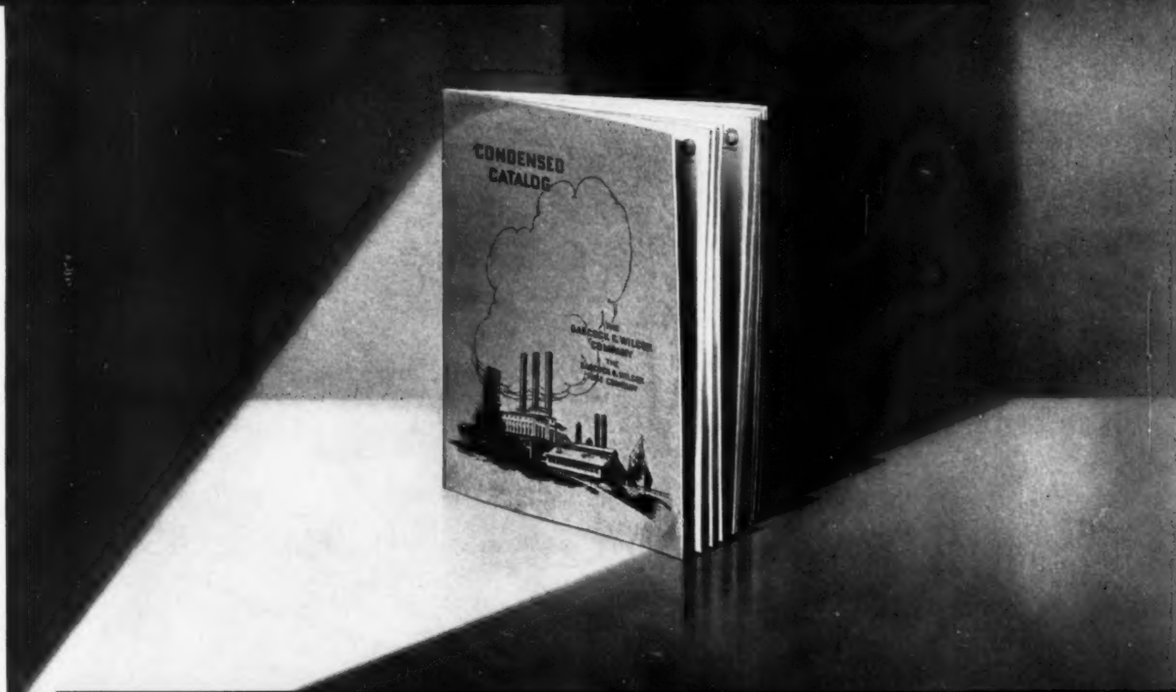

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MECHANICAL ENGINEERING

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Contents for August, 1932

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WHAT IT'S ALL ABOUT

OUR cover picture this month is an unusual view of a locomotive. We chose it because it was admittedly striking and because we were thinking about the transportation problem. Who is not? It is the time of the year when most of us are thinking of boats and trains and motor cars to get us from shop and office to shore and mountain. We choose our destination and then, with time table or road map, lay our plans easily and with precision. No distance is so great and no place so inaccessible that we dismiss it from consideration on these grounds alone. A century of construction in transportation networks has opened most of the civilized world to us. Transportation is a part of modern life.

There are others who think of transportation in other terms. It is the movement of goods that interests and fascinates them. Farm and factory, mine and forest are brought to the market place. There is no need to produce a majority of necessary commodities in our own dooryards. Wheat can be grown where economically it should be grown and distributed by the transportation system to the districts that need it. And so with all food stuffs and all other commodities. Day by day, as transportation facilities develop, the world moves closer in upon itself, at the same time decentralizing its congested centers. Even so great a lover of unspoiled nature as Thoreau had his imagination stirred by the trainborne freight that passed through the environs of Walden Pond.

Still others, thinking in Icarian terms, have vividly before them the dramatic flight of Governor Roosevelt to the convention that nominated him as its candidate for the Presidency. The way of a bird in the air—swift, direct, unhampered by mountain or water—a modern mode of travel that represents the latest triumph of science and human skill. In 1857, Oliver Wendell Holmes, who was an enthusiastic oarsman, wrote about the racing shell: "This, in sober earnest, is the nearest approach to flying that man has ever made or perhaps ever will make." But 25 years later he footnoted this statement by recalling that the bicycle had been introduced since then, and concluded: "There seems to be nothing left to perfect in the way of human locomotion but aerial swimming, which some fancy is to be a conquest of the future." Within another quarter century the Wrights were at Kitty Hawk, and in the present year of grace the Atlantic Ocean has been spanned in less than 12 hours.

Are there then none but roseate hues in this picture of transportation? Unfortunately, stubborn economic facts stand out as contrasting shadows across it. For there are those who may not romance about it—who must face stern realities. Kipling, in describing the overloaded, undermanned freighter *Bolivar* in a storm says: "Then the money paid at Lloyds caught her by the keel." Twenty-two billions of dollars are today catching at the keel of the great railroad argosy that is foundering in the seas of competition and business depression, and nearly a million shareholders are watching the spectacle, wondering what the outcome will be. With them are an even greater number of bond holders. Banks and insurance companies have a vital interest in the outcome. Nearly two million employees find themselves directly concerned. The situation is one of immediate national concern. None can escape the influences of the outcome.

WRITING in the March, 1931, issue of MECHANICAL ENGINEERING on "Competition in the Transport Industry," Dr. Julius H. Parmelee, director of the Bureau of Railway Economics, discussed the problem facing the railroads today as a result of many forms of competition arising out of other transportation agencies. Highway, airway, pipe line, and electric power line have made serious inroads on the business which the railways were organized to conduct. Dr. Parmelee gave the statistics, and asked some searching questions in regard to the public attitude toward the question. "Will the problem gradually expand into a fight to the finish among the several transport agencies?"

This month Mr. Leon Cammen makes one of those fight-fire-with-fire suggestions looking toward a unification of certain transportation facilities that is intended to help the railroads to get back some of their lost business and provide new sources of revenue for them. Beyond these features of a better coordinated transportation system and possibility of increased railway revenue, Mr. Cammen's scheme involves construction on a scale that would provide widespread industrial activity and employment.

Briefly, what Mr. Cammen proposes is the decking-over of railway rights of way on trunk lines in such a manner as to provide a high-speed motor toll highway, and a high-speed suspended passenger railway in addition to the familiar surface transportation facilities already in existence. This is a larger order. It might easily involve, Mr. Cammen estimates, the floating of a billion dollars worth of securities every year for the next six to ten years. And that's something to think about.

One of the surprising features of Mr. Cammen's scheme is that only as it is a combination of well-known elements has it any particular novelty. We have tried to bring out this idea in the illustrations. There is nothing new in a privately owned motor highway or toll road, there is nothing new in elevated motor highways, and while they may be less familiar, suspended railways for passenger traffic have been built. Mr. Cammen merely

brings them together in a scheme that will not require purchasing a right of way because it already exists, and in such a manner that the railroads can benefit. It is something to ponder over. Maybe you can think of a better scheme.

LAST month Mr. William A. Haven described an interesting example of Russian planning in the construction of the great steel works at Magnetogorsk. So much has been said recently about the "Five-Year Plan" that the phrase is taking on certain mythical properties. Economic planning has been repeatedly proposed for the United States by many writers on economic subjects and the problems of the day. Some persons will have nothing to do with economic planning because to their way of thinking it smacks too much of communism. Others say, "Go to, we have had economic planning in this country for years."

Professor Shepard is one of the latter. As a student of our industrial life he recalls the very important contribution that Frederick W. Taylor made to planning in industry. Splendid results have been obtained in innumerable instances where scientifically planned programs of economic development have been worked out in both small and large projects. Engineers at least, in this country, are familiar with planning.

Professor Shepard believes that developing social planning out of industrial planning is to spread a knowledge of planning among our people. It seems to him that engineers should become propagandists of the application of planning as they understand it to such activities as churches, lodges, societies, towns, and other opportunities as they are met with. He gives as an example of an application of social planning in a decentralized and unauthoritative way the methods of the School of Agriculture of Purdue University in its Outlook Reports which are, in effect, plans for production for farmers.

RECENT occupational surveys of graduate engineers have raised important educational problems for engineering schools. One of the first of these surveys, conducted by the Society for the Promotion of Engineering Education in 1924, brought to light an unmistakable drift of engineering graduates from purely technical to partly or wholly administrative duties. Subsequent surveys, and in particular that conducted by The American Society of Mechanical Engineers and reported in the September, November, and December (1931) issues of MECHANICAL ENGINEERING under the title, "1930 Earnings of Mechanical Engineers," gave general support to the S.P.E.E. findings. A secondary drift from positions of technical management to those of general management has also been disclosed. The net result is that at 55 years of age three-fourths of the total number of engineers are in industrial administrative work.

Obviously such a condition of affairs must be taken into consideration by those who are charged with the education of professional engineers. Engineering schools are faced with the problem of a predominantly executive profession in the occupations of its members; a training that, in the opinion of its graduates, has been ineffective in developing qualities of leadership that underlie executive success; and a growing body of opinion that executive traits can be developed by training. To this problem William E. Wickenden, president, Case School of Applied Science, who headed the S.P.E.E. investigation, and Elliott Dunlap Smith, of Yale University, who analyzed the results of the A.S.M.E. study of 1930 earnings of mechanical engineers, direct attention in this issue in a paper entitled "Engineers, Managers, and Engineering Education."

NON-TECHNICAL aspects of engineering are being emphasized more and more every day. Witness, for example, the astonishing interest and intelligence that engineers are showing in questions of social and economic significance and in the revelations that occupational studies have made of the engineer as manager where his success depends upon the skilful handling of human relations. Further evidence of these non-technical aspects, and of the understanding of the human problem involved in particular, is found in the design of products for the popular market. Here engineers have discovered a very real need for a sympathetic study of the buyer and of his peculiarities and tastes. The time has past when the mere value and convenience of a mechanical contrivance or a manufactured article can guarantee its sale. So keen is competition in satisfying the needs of consumers that careful study of numerous details is essential. Robert F. Elder, assistant professor of marketing, Massachusetts Institute of Technology, discusses this question in the present issue of MECHANICAL ENGINEERING. Engineers who are responsible for product design will find much of value in his article.

ONE might almost imagine that engineers have wholly forgotten to concern themselves with the more technical aspects of their profession after viewing this month's list of papers. What with trying to help out the railroads, suggesting modest ways of getting the bulk of our people plan-conscious, emphasis on the managerial functions of an engineering career, and a study of consumer whims as affecting product design, such an opinion might well be justified. And so, to remind our readers that there is still much of a technical nature being considered by engineers, we invite attention to the two papers on the subject of power, to the study of the measurement of surface temperatures, and to the concluding article of a series of six on the basic laws and data of heat transmission.

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Bayonne Bridge Over the Kill van Kull, Between New Jersey and Staten Island

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The TRANSPORTATION DILEMMA

A Suggested Scheme for Bringing About the Coordination of Rail, Motor-Truck, and Bus Transportation

By LEON CAMMEN[1]

BOOM periods in the history of the United States have usually been based on developments in some one or two key industries. In the years following the Civil War, transportation by rail supplied this basis, while steel and oil functioned similarly for the boom that occurred in the period between the Spanish-American conflict and the first rumblings of the storm that brought about the World War. Then followed a brief period of munitions profits, after which the automobile industry became for a time the cornerstone of our national prosperity, while the boom of 1926 to 1929 was greatly assisted by the mushroom growth of the radio industry. Emergence from the present slough of despond would be greatly accelerated by developments in another key industry; hence the question arises: What is this industry?

A careful analysis indicates that the greatest need of the country today is an integrated and properly organized industry of transportation, meaning by this an industry including all forms of transportation—railroads, motor trucks, passenger cars, buses, and airplanes.[2]

We have no such industry. We have railroads in which enormous sums are invested, but several new forms of transportation—pipe lines, trucks, automobiles, buses, airplanes—enjoy practically unrestricted competition with the railroads and are themselves operated without regard to national requirements and for individual, and often temporary and elusive, profits.

While no new railroads of importance have been built in the last twenty years, considerable improvements have been made which have enormously increased the carrying capacity of existing roads, with the result that today they have more than the traffic demands, and, because of lack of business, are operating at such low efficiency that most of the lines are producing less profit than similar investments in other fields of business. Several large systems are in the hands of receivers, and others are being kept out of them either by loans made from funds provided by the Government or by the unusual expedient of raising freight rates so that the stronger lines can surrender the money thus obtained to bolster up the tottering credit of the weaker ones.

[1] Consulting Engineer, New York, N. Y.

[2] In this connection, the reader's attention is directed to an article by Julius H. Parmelee, director of the U. S. Bureau of Railway Economics, that appeared in the March, 1931, issue of MECHANICAL ENGINEERING, p. 177. This article, entitled "Competition in the Transport Industry," is a statistical study in which Dr. Parmelee discusses modern transportation developments and the economic problem underlying them, and points out the possibility of ruinous strife arising among the several transport agencies unless solution is sought through orderly and intelligent coordination and adjustment.

The existing situation is a difficult and disturbing one. On the one hand the transportation agencies competing with the railroads have a perfect economic justification and have come to stay. It would be possible by means of punitive taxation or special restrictive legislation to impose such handicaps on their operation as to make their competition with railroads ineffective, but this would simply mean that traffic would be forced into less suitable channels and the result would not be to the ultimate good of the community. On the other hand, the railroads are necessary, because they still constitute and apparently will continue to constitute for a number of years the cardinal method of transportation, the only one for the heavy commodities. Therefore any weakening of their operative mechanism is done at the expense of the whole nation.

The most important task today in so far as national economics is concerned is therefore to coordinate the various transportation factors in such a manner as to change the present chaos into a balanced industry of transportation. It is the purpose of this article to suggest a means by which this can be done, and which will at the same time provide an enormous amount of business for our key industries and also improve the financial standing of railroad securities.

WHITHER RAILROADS?

The railroads are more than a business owned by their stockholders. The public nature of the industry has been widely recognized both socially and by legislation, with the result that, for example, a railroad company cannot discontinue operation on any of its branches or lines without first obtaining the permission of public-service commissions within the state and of the Interstate Commerce Commission where interstate traffic is involved. Certain goods such as heavy iron or steel products, coal, grain, etc. cannot be transported economically by any other means than the railroads. We cannot, however, by means of competing forms of transportation take away the most lucrative business of the railroads and leave them with the least profitable traffic, and then expect them to run safely and efficiently unless we either provide a subsidy for them out of taxation or have them taken over by the Federal Government and run like the Post Office as a public utility, paying again by means of taxation any deficits in cost of operation and providing out of the taxpayers' pockets the capital investment required to maintain the carriers in an efficient and up-to-date condition.

Of late it has been suggested that the railroads should

extend their operations to include highway transportation, either by building up motor-truck and motor-bus systems of their own, or even by building special highways owned and used exclusively by railroads. While this is possible, certain objections have been raised. If the railroads operate motor trucks and motor buses, their position in asking for protection against unfair competition on part of these forms of transportation becomes untenable. Obviously they cannot, for example, complain of low taxation on buses and trucks while enjoying the privileges of such a situation.

As to the building of highways to be owned by the railroads, two objections may be cited. In the first place, the legal and constitutional questions involved are both complicated and uncertain, and secondly, the cost of such highways would be stupendous. The land would have to be taken by condemnation; and it has been estimated that a new railroad line from New York to Chicago would cost more than the value of all the railroads west of the Mississippi River, the greatest share of this huge cost being chargeable to the condemnation costs of the land. The right of way for a new highway of a length sufficient to make an impression on national traffic would cost the railroads more than the lines it was designed to protect. Obviously a solution must be sought elsewhere.

To sum up, our railroads have grown economically weak and lack capital for necessary improvements largely because of competition by motor vehicles. The latter cannot operate most effectively because of limitations of the highways, which, in turn, cannot be properly improved because the billions of dollars necessary to do the job right are not available and because so much money cannot be invested in such an enterprise unless it promises to become self-supporting.

As a possible solution to the problem of modernization and coordination of our various means of transportation, the author offers the following.

Coordination of railroad and motor traffic of all kinds can be accomplished by building trestles for elevated railways and high-speed motor highways over the trunk-line railroads. This will provide rails on the ground, for the use of freight, commuting, and local accommodation traffic. The through-express passenger trains will be suspended overhead from the trestle, while its upper surface will be concreted and used as a super-highway or toll road. This highway will be, of course, a toll road.

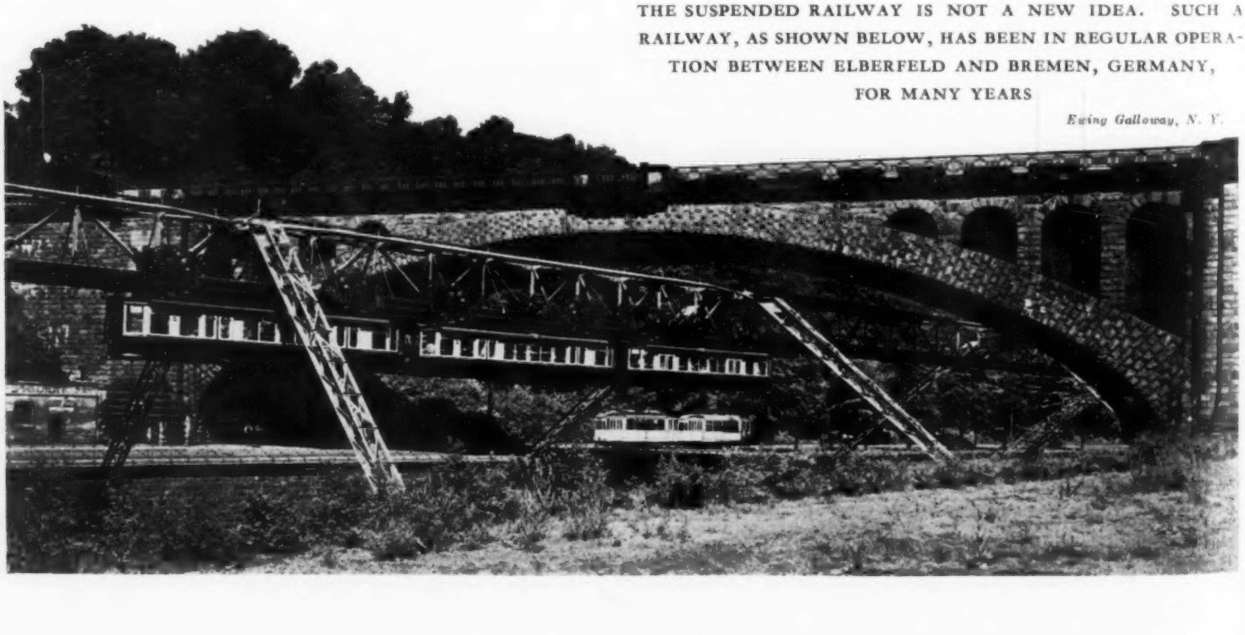
There can be no objection to this system by the public because those who do not wish to pay the tolls can still use the state highways free. The local communities not only will not object to such a system, but will welcome it, because it will take off their roads much of the through traffic which does the community no good and merely increases the cost of highway maintenance.

The elevated highway will be provided with two traffic lanes in each direction, one for slow vehicles (that is, those running under 45 mph) and the other for fast vehicles with a permissible top speed of, say, 70 mph. The toll highway will have an advantage for the slower as well as the faster vehicles because of greater safety, and also because it will not be necessary to slow down for crossings, traffic lights in cities, curves, etc. With all cars running in the same direction, the fast cars segregated from the slow ones, and complete absence of crossing and pedestrian traffic, it will be unquestionably possible to operate well-built automobiles at the high speeds indicated above with very much greater safety than they can be at much lower speeds on the highways of today.

At certain intervals roughly corresponding to railroad stations, special ramps will be provided for the ingress of cars to the highway and egress therefrom, the station master acting as collector of tolls at the smaller places. In some places certain difficulties would have to be overcome; for example, where the railroads pass through tunnels. Some bridges would have to be reconstructed

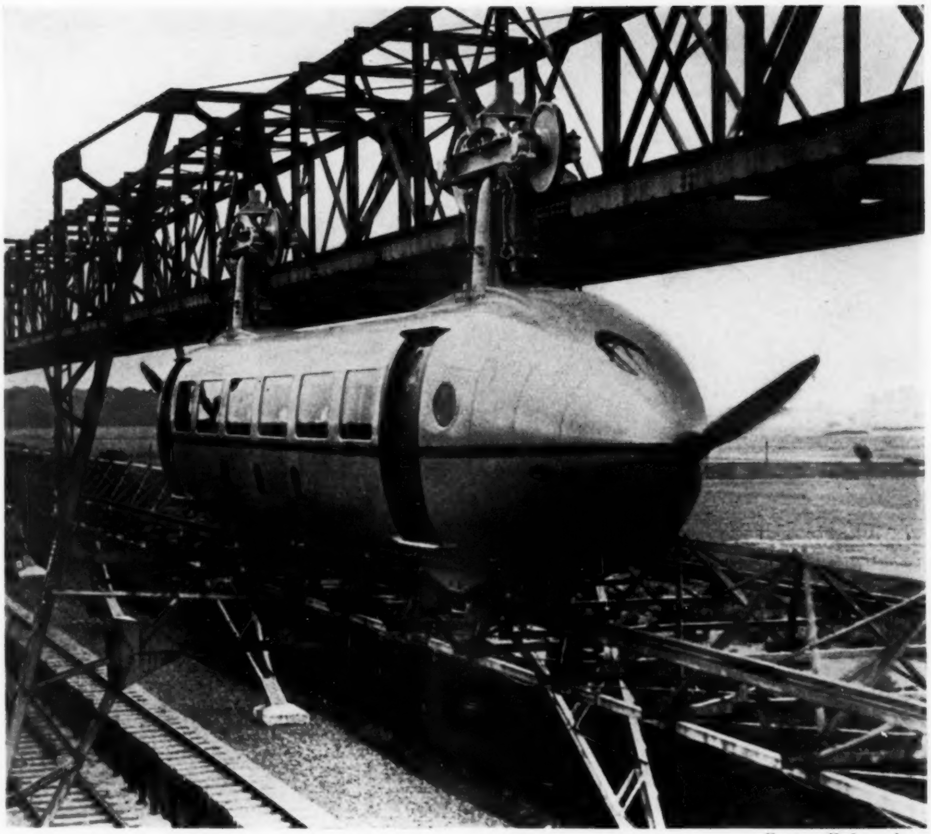
THE SUSPENDED RAILWAY IS NOT A NEW IDEA. SUCH A RAILWAY, AS SHOWN BELOW, HAS BEEN IN REGULAR OPERATION BETWEEN ELBERFELD AND BREMEN, GERMANY, FOR MANY YEARS

Ewing Galloway, N. Y.



to provide the additional headway required. These are, however, only secondary problems which would have to be solved individually, with due regard to the facts in each particular case.

The engineering factors involved in converting through-express passenger traffic of the present type to one suspended from overhead trestlework are not unknown to the engineering profession. They will require careful study before adoption on the vast scale contemplated here, but fundamentally the problem was solved long ago. Such a railroad has been in existence at Langen, near Elberfeld, in Germany, for 28 years, and has carried millions of passengers without fatal accident. Of late, several other systems have been developed, in particular, one by George Bennie in Scotland.[3]



Keystone-Underwood

THE BENNIE RAILPLANE RAILWAY, SCOTLAND

The suspended rail car contemplated is not of the gyroscopic type, but is hung from wheels running on rails that are suspended from the trestle. The drive may be either directly to the wheels or by means of air propellers. In tests with this latter type on the ground, speeds of the order of 125 mph have been attained, while Bennie has run trains on his experimental track at speeds only a trifle under 150 mph. There is no reason why with this type of rolling stock there should be any sacrifice in comfort and safety of the passengers, as the system would be applied primarily on trunk lines with two independent lanes of traffic provided with proper block protection. With the trains running in one direction only on each track, and all trains being of the elevated type, only comparatively simple and inexpensive methods of signaling would be required, while the fact that the track and signal system are protected from snow and freezing would insure a very superior degree of safety of operation.

THE ADVANTAGES OF GREATER SPEED

The competitive position of railroad passenger transportation under these conditions would be substantially as follows: The rapidity of traffic and the greater frequency of train service consequent on the use of shorter trains would increase the attractiveness of railroads as a means of transportation. Even with the faster automobile traffic made possible by the super-highways, the railroad trains would run so much faster as to offer an important advantage. Buses, for reasons of safety, would not be permitted to operate even on the new highways at speeds which would in any way approximate the rail car's average of 125 mph, so that the latter would be able to dominate passenger transportation for distances in excess of 300 miles. The airplane would still remain the fastest method of travel, but it will probably take many years and vast expenditures of money to build up the airplane industry to a point where it will seriously affect the earning capacity of the more conventional means of transportation.

Speeding up traffic as proposed will probably affect materially the sleeping-car situation. Today any passenger traffic in excess of 400 miles has to be carried on primarily by sleeping cars. If, for example, one could leave New York at nine in the morning and reach Pittsburgh at noon, it would be possible to transact business, take an evening train, and be back in New York before midnight. This in turn would so materially reduce the total cost of the trip as to place the railroad beyond the competition of private automobile and bus.

[3] See "New Methods of Rail Transportation," Mechanical Engineering, March, 1931, p. 190, in which the Bennie railplane railway, a German air-propeller-driven car, and a proposed suspended-monorail railway of American design are described.

N. J. State Highway Commission

AN ELEVATED MOTOR HIGHWAY ACROSS NEW JERSEY MEADOWS, UNDER CONSTRUCTION AT THE PRESENT TIME

In this connection it should be emphasized that every means of transportation with the exception of the railroads is being speeded up and is capable of a very considerable further speeding up in the near future. In so far as the present railroads are concerned, there are very definite factors limiting either the technical possibility or the economic advisability of handling passenger traffic very much faster than it is done today, particularly where the passenger trains have to operate over the same tracks as freight trains. Over certain four-track routes such as from New York to Washington, and Chicago to Cleveland, passenger and, particularly, mail trains already operate at speeds as high as 80 mph, but such operation is somewhat unusual and not always possible. The jump from the present fortuitous top of 80 miles to regular schedules based on a speed of 125 to 150 mph is, however, something which no railroad engineer, and particularly no railroad maintenance-of-way man, would for a moment think possible. What, then, is going to be the outcome of this situation, with the railroads as the transportation snail, past which private automobiles, buses, and airplanes whiz at ever-increasing speeds? The answer to this is hardly apt to cheer up the stockholders of railroad companies.

EFFECTS ON FREIGHT TRAFFIC

We now come to the question of freight traffic. Here three phases have to be considered—the changes in

Ewing Galloway, N. Y.

SECTION OF NEW YORK CITY'S RECENTLY OPENED WEST SIDE ELEVATED HIGHWAY


Courtesy Italy America Society, N. Y.

AN ITALIAN AUTOSTRADE, A TOLL MOTOR HIGHWAY FROM ROME TO OSTIA

freight traffic proper, the competition of motor trucks, and the prospects of motor trucks using elevated super-highways. The elimination of through-express passenger traffic and the use of the ground-level rail system for freight only (excepting a slight injection of passenger traffic in the way of commuter and local accommodation service) will create conditions conducing to the remarkably efficient and cheap handling of freight traffic. It will make it possible to handle freight much more expeditiously than is the case today, and will reduce the cost of freight transportation to a point where a goodly share of the traffic now lost to motor trucks will be attracted back to the railroad.

On the other hand, there are certain kinds of freight which the railroads are not equipped to handle. These are, in particular, commodities of low unit weight and high perishability. Furthermore, where the commodity is shipped in small packages and where neither the shipper nor the consignee is located on a railroad siding, motor trucks can do the job better than railroads. For a good many commodities, for distances up to 150 miles, shipping by truck is not only handier but also cheaper, and in view of the comparatively short distance that they would have to carry the goods in such cases, it might even be to the advantage of the railroads to get rid of such traffic.

Today, however, any traffic that trucks take away from the railroads is irretrievably lost to the latter. With the advent of the railroad-owned elevated highways, however, a large share of this traffic will be hauled by truck over these highways and will therefore pay toll to the railroad companies. Motor trucks use the common highways today, and this cannot well be prevented because no other highways exist, although heavy truck traffic is particularly hard on them. Through truck traffic brings no benefits to the townships and states through which it passes. On the contrary, it causes a congestion of the highways and thus makes local traffic less attractive than it would otherwise be. The moment, however, that an elevated highway becomes available to through traffic, there will be no reason why such traffic should be permitted on surface roads.

What has been said about trucks and private cars applies likewise to buses. Because of certain developments on the railroad itself, it is not expected that the bus will continue to grow as a railroad competitor. This applies at least to the long-distance transportation of passengers. On the other hand, the buses will be very useful in carrying traffic for shorter distances, particularly to points where transportation service by other means is either lacking or inefficient. If the buses can parallel the railroads on part of their lines, they will unquestionably use the super-highway in order to at-

tract or hold their passenger clientele by cutting down as much as possible the time of transportation between the various points on their route. If the buses use the super-highways, they will pay toll.

THE FINANCIAL HURDLE

The financing of the scheme here proposed is obviously the most serious difficulty in the way of its accomplishment, inasmuch as it would be necessary to trestle the entire length of our major railroad systems east of the Mississippi River. At the present writing it is possible to give only a very rough estimate of the expenditures that this will require. This estimate is set at about ten to twelve billion dollars. For obvious reasons this money will have to be raised by the sale of securities to the public. Railroad securities have suffered a tremendous loss of value in the last few years, partly due to general economic conditions, but even more so to the public's loss of confidence in the future of the railroads as the cardinal transportation agency. A market for new railroad securities will be created if this confidence can be restored, and the only way to do this is by showing that the railroads are alive to opportunities. Spent over a period of, say, six to ten years, this would mean the sale of about a billion dollars' worth of securities a year. The amount thus raised would immediately be spent at home on new construction requiring the purchase of huge amounts of steel, concrete, copper, aluminum, and labor. Railroad spending would therefore react on industry in general, which, in turn, would increase the earnings of the producing companies and enhance the value of their securities, thus providing the psychological background necessary to incline the public to buy the additional railroad securities.

Another angle which must not be lost sight of is the influence of the proposed scheme on the destinies of the automobile industry. The construction of special elevated highways where travel at speeds up to, say, 70 mph will be made possible and safe, in so far as traffic conditions proper are concerned, will create new automobile business. This applies with as much force to motor trucks as to passenger automobiles.

It seems to be an inescapable conclusion that the railroads cannot go on as they are going, but must take drastic steps to pull themselves out of the slough of despond and mischance in which they are more and more becoming mired. To revitalize an industry represented by some $22,000,000,000 worth of securities, the adoption of a really big program is necessary. Any scheme to restore such a huge and badly shaken industry to normal must be spectacular and comprehensive enough to show from the start its ability to become a major factor in the life of the nation. With this condition satisfied, the public, which in the last few years has seen a distressing shrinkage in the value of railroad securities, will be willing to provide the carriers with additional billions of dollars without feeling that it is "throwing good money after bad."

CONDITIONS CALL FOR CHANGES

The railroads of the United States are physically a splendidly organized system, and on the whole they are well managed. They constitute the key to the industrial life of the nation, and their financial plight is due primarily to the fact that the railroad as George Stephenson conceived it more than a century ago, has outlived its former dominant position in the industry of transportation. The railroads have not radically changed their technical structure to meet more modern conditions of competition in the field of transportation. It is immaterial where the fault lies, but it is important that changes be made. Present economic conditions require that they should be made without delay, and on a scheme commensurate with the magnitude and importance of the interests involved.

WHERE MOTORISTS PAY TO TRAVEL.... A FAMOUS TOLL ROAD—THE LONG ISLAND MOTOR HIGHWAY

PLANNING *for* PROSPERITY

By GEORGE H. SHEPARD[1]

RUSSIA is operating production and regulating consumption by a plan of national scope and centralized origin. The United States Chamber of Commerce has offered a general plan for American industry. The Swope Plan and the Ten-Year Plan of the American Federation of Labor have also commanded attention. Other persons and groups are advancing the idea of social planning.

These things are all evidences of a dawning recognization that such troubles as the present financial depression cannot be prevented except by applying to society as a whole, to national and even to international problems, the orderly and systematic foreseeing of events and provision for them which have worked so well in the individual factory.

A government whose people have never known anything but despotism can put forth a national plan and enforce it. To do anything of the sort with a people so devoted to liberty and individual initiative as ours would be impossible. To bring our undisciplined people voluntarily to accept any general social plan is tremendously difficult.

In this situation the engineer is justified in speaking out, because he has had an experience in planning which no one else has had.

About fifty years ago Frederick W. Taylor began the development of industrial planning. Because his first work was done in machine shops, the impression prevailed for a long time that his ideas applied only to that industry.

Gradually engineers and industralists realized that any kind of production could be planned—not only could be, but must be, if minimum cost was to be attained. Planning production brought realization that production, finance, and sales were interdependent, and that all three—that is, the whole business—must be planned as a unit in order to secure a really good plan of any part of it.

DIFFICULTIES OF PLANNING THE INDIVIDUAL BUSINESS NOW OVERCOME

In the course of these fifty years we have pretty well overcome the difficulties of planning the individual business. At least we have learned to look at and attack the whole problem as a unit and not to improvise piecemeal solutions as we go along.

One of the most successful methods of engineers is to tackle a problem in a small way, work out a solution on a small scale, and then by scientific theory and research, combined with practical experience, gradually extend the scope of the solution to the problem on a large scale.

That has been exactly the method of development of planning as above outlined. Moreover it is characteristic of engineering progress. By this method, engineers have brought the huge locomotives of today out of Stephenson's *Rocket*, forty-thousand-ton steamships out of Fulton's *Clermont*, modern machine tools out of the footpower lathe, talking motion pictures out of the kinetoscope, the automobile out of the horseless carriage, and the radio out of the wireless telegraph.

Is it too much to expect that the same methods will bring a national, even a world, planning department out of the planning department of the factory?

THE CHARACTERISTICS OF A GOOD PLAN

What are the characteristics of a good plan, in so far as our experience to date enables us to answer that question?

It must:

1 Be based on known facts
2 Attack the problem as a whole
3 Be sufficiently flexible to allow for unforeseeable contingencies
4 Decentralize enough to make plans workable and to allow for individual ability and initiative; and
5 Centralize only enough to secure effective control.

What are the necessary and immediately practicable steps in developing social planning out of industrial planning?

The author believes that the first step is to spread the knowledge of planning among our people.

Of course, the problem bristles with difficulty; but already we can realize that we have in the planning department of the factory a device that has worked well on a small scale, and so there is reason to believe that its usefulness may be extended to a degree which cannot now be foreseen, and which may, indeed, have only worldwide limits.

People in general not only do not appreciate, but have no conception of, up-to-date industrial planning.

Therefore it seems to the author that engineers should become propagandists of the application of planning as we understand it to every human activity: to churches, lodges, societies, towns, and to whatever larger fields opportunity may give them access.

In municipal government the ice is already broken, because the city planning commission is already well known; but it is usually limited to the preparation of a zoning ordinance or something of the sort, and then goes out of existence; and no city has a planning department in the sense that a factory has one.

In the United States, a useful device in government is

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generally applied first to a small unit; then, if it proves successful, it is gradually extended to larger and larger units, until finally it is adopted by the nation as a whole. It seems to the author that the application of planning, as we understand it, to the life of human society, including government, must be worked out in this fashion.

CENTRALIZATION MUST BE AVOIDED

Our experience thus far indicates that throughout this process we must avoid overcentralization. Engineers made their own mistakes in this matter, which later they had to correct. In the early development of industrial planning, engineers tried to put very detailed control into the hands of a central planning department, necessarily more or less remote from the actual work, leaving to those in actual contact with the work only a very exact obedience to orders. Such schemes broke down because distant control required that conditions at the work place should be almost perfectly standardized. Since errors cannot be wholly prevented, they must be rectified, and to do so there must be individuals of the necessary ability on the spot, and they must have enough freedom of judgment and of action for the purpose. Engineers now decentralize planning and take care to leave to those on the job a sufficient amount of discretion. Even where the material is moved from process to process by conveyors, a large amount of elasticity has to be given to the plans of the central department, so that foremen and even individual workmen in the shop enter into the planning to a surprising degree.

If planning is not thus decentralized, the workers on the job soon see that the central planning department cannot handle details as well as they could themselves; and under this knowledge their morale rapidly deteriorates.

SOCIAL PLANNING SHOULD BE AS LITTLE AUTHORITATIVE AS POSSIBLE

It is to be hoped that social planning may be as little authoritative as possible.

The methods of the School of Agriculture of Purdue University seem to the author to indicate how planning may be decentralized and unauthoritative, and at the same time effective.

Under the chairmanship of Prof. O. G. Lloyd, the Outlook Committee of the School of Agriculture prepares outlook reports to the farmers of Indiana, which are, in effect, plans of production.

Our committee has no authority, and does not attempt to exercise any. It warns the farmers against overproduction; and, to make its warnings effective, it recommends to the farmers other crops on which they will have a better prospect of profit. In order to regulate time schedules, for example, in raising hogs, it recommends to the farmers the breeding and feeding schedule which is most likely to be profitable.

James W. Hook, president of the Geometric Tool Company of New Haven, Conn., in an address before The American Society of Mechanical Engineers on December 2, 1931, pointed out that the Federal Government has already done something of this sort and may do more. He said in part:

> Stabilization of business, involving the control of production and regulation of consumers' demand, is another matter in which government should be vitally interested. The first step in its accomplishment awaits the call of government for all units in each competitive field to meet in Washington for the purpose of discussing matters of mutual interest. Sound decisions growing out of these meetings should be applauded and given the moral support of government. A precedent for this has already been established. When the simplification movement was started, a department of the Federal Government assumed the leadership, called competitive groups together and showed them the way. Results were immediate and far-reaching. Certain businesses, and even certain industries, that were floundering on the ragged edge of failure, were shown the way to profits and success without adding a penny to prices that the public had to pay. Let government foster and encourage an industrial-stabilization movement in the same way that it handled and directed the simplification movement. Let it call competitive groups together for the purpose of finding ways and means of controlling production, forecasting consumers' demand, standardizing reserves for depreciation and obsolescence, establishing sound costing practices, and eliminating unfair and cutthroat competition that deprives workers of all advantages gained by technological advances and engenders everlasting suspicion and hate between competitors.
>
> This is the sort of a national planning program that our Government could embark upon with all safety. And in my judgment it would be many fold more effective and successful than any super board that could be selected. For what super board of human beings would have the fortitude, much less the mental capacity, to master the enormous detail of American finance and business sufficiently to direct its mass movements toward a certain goal?

WHO SHALL UNDERTAKE SOCIAL PLANNING?

On the other hand, it may be that social planning can best be applied by some device outside of law and government. That is part of the problem which needs to be worked out. There is at least a danger that such a device, by sheer economic value, might acquire power to an extent which would be dangerous in an extra-legal agency.

Once let the thing get off to a good start and it is bound to grow, because the nature of planning is to extend itself to larger and larger areas. Any plan soon finds itself in contact with others. The next step is to harmonize these plans; and the next, to plan them all as one.

PLANNING NOT THE ONLY THING NEEDED

Planning is not the only thing needed; but planning brings to light unrealized causes of loss as obstacles to the plans. Then, if the management is at all competent, these various obstacles are removed, conquered, or avoided.

If serious errors in the development of social planning are avoided by the method of experiment and gradual growth which the author believes to be necessary, then it may be that the social plan will enjoy the same confidence that the industrial plan now receives in the factory; and such general confidence will do much to prevent the widespread fear which is so large an element of our present troubles.

Engineers, Managers,
and ENGINEERING EDUCATION

A Discussion of the Educational Problems Raised by Recent Occupational Surveys

By WILLIAM E. WICKENDEN[1] and ELLIOTT DUNLAP SMITH[2]

ENGINEERING education is an important pathway to executive responsibilities. Three-fifths of all engineers who live a normal life span, spend over half their working lives in technical or general administrative work.[3] Over half of those in administrative posts in industry spend most of their working lives in general management. The demand for engineers in administrative positions is so great that these positions offer engineers remuneration considerably larger than that offered for engineering work which does not involve some responsibility for the management either of men or of affairs.

This situation was first indicated by a survey made by the Society for the Promotion of Engineering Education in 1924.[4] This survey covered the work and earnings of 5000 engineering graduates. Later, less extensive surveys gave general support to the S.P.E.E. figures. Last fall The American Society of Mechanical Engineers published the results of a second extensive survey. This survey covered the work and earnings in 1930 of 9000 mechanical engineers[5]—over half of the membership of the Society. It gave almost identical results on all common points with the S.P.E.E. survey. The fact that the results have remained constant over a period of seven years gives them added weight.

The drift of engineering graduates from purely technical to partly or wholly administrative duties that was indicated by the S.P.E.E. survey, is shown in greater detail by the A.S.M.E. survey. In the first five years of practice only one-sixth of the mechanical engineers attain posts involving administrative duties. With each year of age a larger proportion assume administrative responsibilities, because progress even in strictly technical work usually involves the management of others. By 40 years of age three-fifths are in positions involving administration. Then the drift stops. Apparently, the two-fifths who do not attain positions of executive leadership by 40 rarely do so at all.

DRIFT OF ENGINEERING GRADUATES TO POSTS INVOLVING ADMINISTRATIVE DUTIES

Among those engineers holding administrative positions in industry, there is a secondary drift from positions of technical management to those of general management. During the first years after graduation, but a quarter of the engineers in administrative positions are in general management. This proportion, however, steadily increases as engineers grow older, until at 40 years of age it is over half, and after 55 almost three-fourths of the total number of engineers in industrial administrative work.

To an astonishing extent the greatest demand for engineers, as indicated by the remuneration offered, is in wholly or partly executive rather than exclusively technical work. This is best seen in a comparison of median salaries, since median salaries are generally accepted as the best indication of the pay of the typical man. The median earnings of non-administrative engineers do not exceed $5000 at any age. The median salary of the engineer in work involving administration passes $5000 at 35 years of age, and reaches $9500 at 55. That of the engineer in general managerial work exceeds $6500 at 35, and reaches $12,000 at 55.

That experienced engineers recognize the executive aspects of engineering work and the consequent importance to engineering success of the capacity to deal with and manage men, was clearly indicated in the S.P.E.E. survey. This survey secured the opinions of older graduates on "the qualities which they seek in younger engineers whom they employ, and on the results of engineering courses." Among these qualities, "good character and qualities of leadership" received by far the highest rating. On the other hand, these same two qualities came last in rating the qualities developed in engineering courses.[6] Similarly, the 1500 engineers who replied in writing to the question, "What are the most important factors in determining probable success or

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[3] Throughout this article the word "administrative" is used functionally to designate any position, however minor, of which management of others is a substantial part. It thus refers as much to such subordinate positions as foremen or supervisor of a drafting or experimental room as to major administrative positions.

[4] See S.P.E.E. Report of the Investigation of 1923–29, pp. 228–238.

[5] See "1930 Earnings of Mechanical Engineers," published in the September, November, and December, 1931, issues of Mechanical Engineering.

Presented at the 40th Annual Meeting of the Society for the Promotion of Engineering Education, Corvallis, Ore., June 29–July 1, 1932.

[6] See S.P.E.E. Report, supra, p. 239.

failure in engineering?" asked by the Carnegie Foundation for the Advancement of Teaching, mentioned personal qualities seven times as frequently as they did knowledge of engineering science or technique of practice.

In 1928, at a conference of deans of engineering schools, Owen Young said: "Technical concerns frequently have to appoint men without technical training to their chief administrative posts because of the tendency of the man working on scientific problems to get too specialized a point of view at the expense of a general capacity to organize or 'command' large projects," and added: "Industry itself often deepens this purely scientific interest by assigning the engineering graduate to routine technical work."[7] At the same conference, Mr. O. H. Cheney, vice-president of the American Exchange Irving Trust Bank, said: "Real knowledge of sound management principles as applied to personnel relations must be a part of every executive's equipment. . . . It isn't merely a matter of being human, it is a problem of being intelligently human. No man is born that way. . ."[8] Mr. S. A. Lewisohn stated: "Of course, we all hear it said, 'Well, the ability to manage men is a matter of innate biological traits. . .' But the difficulty is that those traits are of no value to any one unless they are developed."[9]

THE PROBLEM BEFORE ENGINEERING SCHOOLS

Thus the evidence presents a rather clear picture of the problem before engineering schools: a predominantly executive profession both in the occupations of its members and in its rewards; a training that, with all its merits, in the opinion of its graduates has been least effective in developing the qualities of leadership that underlie executive success; and a growing body of opinion that executive traits can be developed by training.

Of course, engineering has become an executive profession on the basis of an exclusively technical training, which until recently rarely deviated from its course even to touch upon the problem of managing men. But until recently there was no other training for administrative work, while today schools of business administration of high quality abound. Moreover the recent statistical study conducted by the Engineering Foundation of data concerning the earnings and occupations in 1928 of 31,000 graduates of land-grant colleges indicates that as between the relative earnings of engineering graduates and of arts-and-science graduates in business, "the advantage appears to lie rather strikingly with the arts-and-science group."[10]

The difficulties in meeting this situation and in securing the opportunities which it offers to engineering students are obvious and real. The engineering curriculum is already overcrowded. To teach the fundamentals of management thoroughly is almost to attempt to teach an entirely distinct profession. To teach the management of men requires developing new methods and embarking in a new field. Under these circumstances it is impossible to speak categorically. The solution, however, would seem to lie along two main lines.

Many, perhaps most, men who come to engineering schools plan to be technical engineers. Although a majority of them later achieve administrative duties, they do so because of technical attainment. Moreover they usually assume administrative responsibilities in technical fields where administration is engineering. For such men, engineering education must remain highly technical. Yet some instruction should be provided to give them a background of industrial-relations experience and principles, and a method of approach to problems of human management. For they must be so prepared that they will learn from experience to deal with human relations in spite of the tendency of industry to start them in work with the minimum of human contact.[11]

Other men—and as their needs are more specifically recognized by engineering schools they will increase in numbers—take engineering courses as a means of gaining an understanding of the technical problems of industry as a preparation for administrative work. Such men need less extensive technical training than the engineer. They need much wider training in the economic and social sciences and in their application in the fundamentals of management, of which the management of human relations is a vital part. In some schools courses of study have already been developed to meet this need.

It is essential not to confuse these two problems: the education of the technical engineer, who, if he succeeds, must almost inevitably assume some managerial duties as part of his engineering, but who is none the less a technical expert; and the education of the general executive, who in this technical age must understand technology in order fully to grasp the problems of his job, but is none the less essentially a manager. Not to see this distinction will be to impair the development of the engineer and yet to fail to develop the manager—for even in this technical age the positions are distinct. Each in its own way, however, involves dealing with men, and often with industrial relations.

In so far as engineering schools train engineers, they are carrying forward an established work. In so far as they undertake to develop technically competent managers, they are taking on a new task. But the surveys of what engineering graduates do and earn, give impressive evidence that in either case it is an important part of engineering education to give students some vigorous training that will equip them to learn from experience to manage men, and that will make them professional in their capacity to deal with the human as well as the material factors of industry.

[7] See "The Teaching of Labor Relations in Engineering Schools," 1928, published by S. A. Lewisohn, pp. 63–64.

[8] See "The Teaching of Labor Relations," supra, p. 19.

[9] See "The Teaching of Labor Relations," supra, p. 9.

[10] "Earnings of Land Grant Colleges," by D. S. Bridgman. *Journal of Engineering Education*, vol. 22, Nov., 1931, p. 189.

[11] For suggestions for courses of this sort see article entitled, "Can the Engineer Be Taught to Manage Men?" in *Journal of Engineering Education*, Oct., 1930, pp. 99–128.

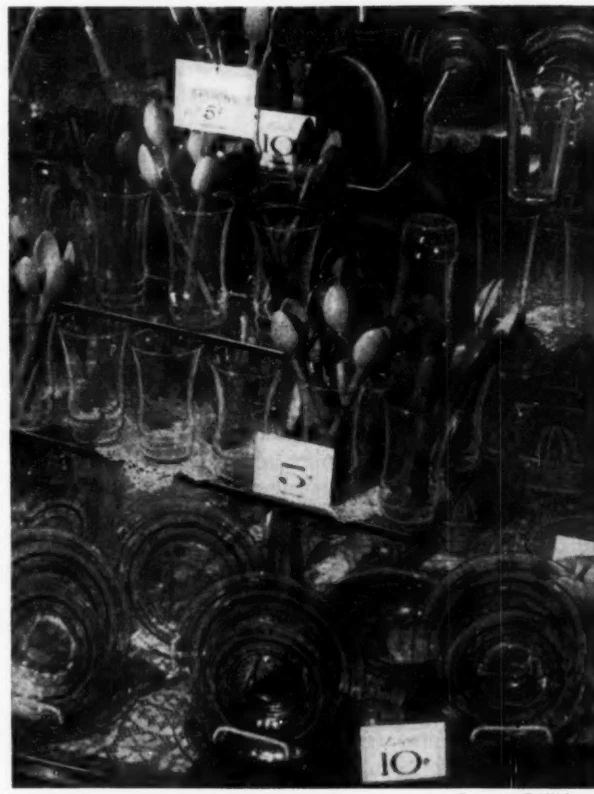
PRODUCT DESIGN *for the* MARKET

By ROBERT F. ELDER[1]

THE increasing complexity of our industrial structure has tended to becloud its fundamental purpose, which is service to the consumer. This is not an altruistic concept. The entire history of industrial development discloses a gradual surrender of the stability and independence inherent in a civilization where each family constitutes an economic unit, in favor of the greater material welfare made possible by an interdependent economic system. Occasionally a Thoreau or a Gandhi rebels against the machine we have built and advocates a return to the simple life. Most of us are less hardy souls. We cherish our creature comforts, and prefer tinkering with our industrial machinery in an effort to correct its manifold shortcomings to scrapping it outright and liquidating our venture.

A great many of our business problems have their origin in our failure to distinguish between the purpose of our industrialism—a higher standard of living for society as a whole—and its motivating force—profits for the individual. The purpose of the automobile is to furnish transportation; its motivating force comes from the gasoline in the tank. To say that the purpose of the automobile is to encourage the use of gasoline is obviously to put the cart before the horse. Yet, the actions of many industrialists seem to testify to a belief that business exists for certain ends of its own, and that the consumer's true place in the picture is to provide the fuel which runs the industrial machine. Witness the recent enthusiastically sponsored campaigns to "Buy Now"—to stabilize industry. Many of our ills seem to be traceable to this failure to distinguish between the purpose and the motivating force of the economic system we have built. It is a logical assumption that in the long run the greatest profits accrue to those who contribute most to the purpose of industry. Certain recent events seem to prove that it is also a practical assumption.

This rather philosophical discussion may seem out of place in a paper on product design. The statements made are not widely questioned. In fact, it has of recent years become quite popular to render lip service to the dogma that "the Consumer is King." Yet as a practical matter of fact it is fairly obvious that the average concern today neither designs its product, nor manufactures it, nor distributes it on the basis of consumer requirements. This is a sweeping statement, but it is emphasized by the outstanding successes which are every now and then achieved by those concerns that, sometimes accidentally and sometimes through intelligent plans, manage to strike a responsive chord among consumers.



Jeannette Griffith

SKILFUL DISPLAY OF ARTICLES OF OBVIOUS UTILITY MAKES MORE EFFECTIVE ATTEMPTS TO DESIGN PRODUCTS THAT SELL THEMSELVES

Under a system of manufacturing goods to the consumer's order, the problem of proper design assumes small importance to the producer. With the increasing tendency to manufacture for stock, the producer's design problem becomes acute. In the former case the consumer exerts a positive and active influence; in the latter case his influence is purely negative and passive. The buyer of ready-made goods is seldom articulate in his criticisms. He expresses his judgment by purchasing or by refusing to purchase. If he does become vocal with complaints or suggestions, the length of the distribution process, with its numerous intermediaries, usually prevents their getting to the producer's ears.

The gap between consumer and producer might have been more readily bridged had it not been for the possi-

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bility of influencing the direction of consumer demand through mass selling and advertising. It became for a time a popular concept of management that the product should be standardized, a process developed for making it cheaply in large volume, and sufficient sales pressure put behind it to force the necessary volume on the market. This theory regarded the product as an incident of the process, rather than the end to which the entire process was designed. It tended to discourage change, and to limit changes to those which could be made without unduly disturbing the process. The consumer's stake in the product was largely disregarded. Some remnants of this attitude still persist. In other cases its fallacy has been recognized, but the lack of understanding of consumer needs which it engenders and the lack of flexibility to respond to those needs, prove serious bars to a proper adjustment.

DESIGN OF MANUFACTURED PRODUCTS TODAY LARGELY INFLUENCED BY TRADITION

The design of most manufactured products on the market today is over-largely influenced by tradition. Today's products pattern themselves on yesterday's ideas of what they should look like, and often neglect changes in their purposes or the conditions under which they are used. This is largely a matter of inertia. The easiest course is to assume that past success guarantees future success. The usual position of the design function fairly low in the organization, and generally as an offshoot of the production department, emphasizes this inertia. Radical changes and improvements seldom originate in the lower ranks. Sad to relate, the radical improvements in an industry's product have usually come from entrepreneurs outside its ranks and unhampered by its traditions.

Nevertheless, it must be granted that this policy of conservatism has certain advantages. The consumer himself tends to be slow in his acceptance of things which differ too radically from those to which he has been accustomed. The enthusiast for change is likely to overstep the bounds of customer acceptance. Witness the ultimate retreat of clothing styles from their periodic extremes to styles which modify the old by certain features of the new. And it may fairly be argued that it is better to continue in the old way than to venture into new designs without adequate knowledge of what the market really wants. To let a business die of dry rot provides jobs for a longer time than to wreck it in speculative ventures, even though both policies lead to the same ultimate grave.

PRODUCT DESIGN UNDULY INFLUENCED BY EXISTING INVESTMENTS IN MANUFACTURING EQUIPMENT

Product design is likewise unduly influenced by existing investments in manufacturing equipment. Reluctance to scrap equipment which is still physically useful too often affects decisions on design. This is largely due to inadequate obsolescence policies which fail to recognize that the cost of equipment should be amortized during the period of consumer demand for its products. The difficulty of measuring equipment obsolescence has too often served as an excuse for neglecting to do anything about it. Another impediment to timely changes in design is to be found in the undoubted overinvestment in highly specialized single-purpose machinery that resulted from the philosophy that regarded the consumer as an adjunct to the process of mass production.

The nature of the manufacturing process too often determines the appearance and specifications of the product, wholly aside from the question of equipment. In most plants the individual in charge of design is more familiar with the technique of production than he is with either abstract principles of design or the requirements of the product's ultimate users. When the sales department, which first senses consumer dissatisfaction through reduced volume or increased difficulty in selling, calls for changes, the changes that are made are only such as can be made within the limitations of the existing manufacturing process, or at best with only minor alterations. From the standpoint of the designer and the production department it must in fairness be recognized that the sales department is seldom able to specify just what it wants in the altered product; and if it can make articulate what it thinks it wants, its conception is seldom adaptable to economical manufacture.

This analysis reveals clearly that the real problem involved is twofold. It is necessary to develop means for ascertaining with some degree of precision what consumers' real wants are, in order that they may be correctly anticipated by manufacturers. Given ways to learn what consumers' wants are, the organization should be so set up as to be able to translate them into production in an economical fashion. Both are difficult tasks. The first, which is discussed later, is perhaps the more difficult, but there is ample evidence that it can be accomplished. The second clearly involves divorcing the design function from its exclusive contact with production and recognizing it as a major problem of the business. There has been an increasing tendency in recent years to recognize in organization the function of "product control" or "merchandising," placing it on a plane commensurate with production and sales, and recognizing it as a coordinating link between these two functions and the customer by whose favor the business lives. The merchandising division has the job of gathering and evaluating information on consumer reactions to the product and consumer buying habits, and of translating it into a basis for action by the production and sales divisions.

This, of course, is much more than a question of organization structure. It involves the very difficult problem of proper personnel. The man who is charged with the responsibility of keeping the design of the product in harmony with market requirements must be a many-sided individual. He must be a keen student of the underlying trends of modern life, with sufficient imagination to realize their import to his own business. He must be sufficiently sales-minded to distinguish between those improvements that consumers would like and those that they will pay for. He must be thor-

oughly acquainted with modern manufacturing processes and materials, their possibilities and their limitations. He must be a man of vision, not hampered by traditional limitations; but not a visionary who refuses to recognize practical considerations. Our industrial development has not been of a kind to produce many such men. Our engineering education has not been able to turn out many men properly equipped for such jobs. Yet with the increasing importance of proper design, with the exhaustion of other competitive possibilities, it is imperative that we find them or develop them.

Inferior design places a terrific handicap on the selling function. The market for poorly designed products is inelastic. Disastrous reductions in price and excessive sales costs are necessary to get rid of designers' mistakes. Soundly designed products enjoy elastic markets. Sometimes slight price premiums can be obtained. Their great advantage, however, is the increased salability that can be achieved within the profit range. The importance of design has been emphasized by the multiplicity of goods among which the consumer must choose. Inferior design on the part of one producer may result in loss of business to a competitor designing the same product better. Poor design on the part of an entire industry may result in loss of possible sales to other industries that have been more alert to the sales value of good design. With a generally rising standard of living, a larger portion of all purchases tend to fall into the deferable class. When a consumer has bought a product that remains serviceable, he can be induced to replace it only by introducing radical improvements. As the range of choice becomes wider and the durability of goods increases, the need for creating obsolescence through better design becomes greater.

ESSENTIALS OF PRODUCT DESIGN FROM THE MARKETING STANDPOINT

From the marketing standpoint, the first essential of product design is of course the proper degree of utility to the customer. It must be emphasized that this does not necessarily mean the highest intrinsic quality or the greatest durability. Ordinarily for any product other than a totally new one there is a fairly definite price range, or perhaps two or three price ranges, which represents the consumer's idea of the value of the product to him. To design a product that falls below the standards of durability or performance available at the accepted level in order to compete on a lower price basis is likely to result in temporary sales gains but not in permanent success. What is not so commonly recognized is that increased durability or performance that forces a price differential outside the range of consumer acceptance is equally likely to result in failure. Quality or performance have in themselves no virtues except as they fill a public demand.

It is of the highest importance, however, that the product be designed so that its utility is obvious in the first casual inspection. Hidden quality is becoming more and more difficult to sell, consequently the designer must face the problem of bringing the quality of the product to the surface. With the present intensity of competition, the tendency toward mechanization of retailing, and the growing emphasis on sales costs, the average product must largely sell itself. The great possibilities of "impulse buying" are being recognized by merchants and manufacturers. Practically all of the important developments in retail-store layout in recent years have been directed toward securing better and more effective display of the product. By making the desirability of the product more obvious, its display serves to reduce the burden formerly carried by salesmen and by advertising. In a sense the product has been made into its own advertising medium. To meet this trend the designer must be well informed on how the consumer buys and uses the product, and what are the factors which influence him in his choice. Where the design function has been related solely to production and engineering, men of the proper background are seldom available. To an increasing degree the design function is coming under the control of the advertising agency. While this is perhaps a good thing as far as salability is concerned, it unfortunately often results in products that are somewhat inferior from the engineering point of view, and in failure to achieve the maximum economies in production. From the standpoint of organization, as has been stated, the problem can be solved by setting up the coordinating function of merchandising.

The problem of finding out what the consumer wants enough to pay for is a perplexing one, but without its solution, changing the organization set-up avails nothing. The consumer is an inarticulate creature. His criticism of the goods put before him is passive, not active. If you ask him what he is going to want six months from now, he cannot tell you, for he does not know. If you ask him how to redesign your product to meet his requirements, he may offer a few minor suggestions, but following those suggestions will not insure his continued patronage. The designer of a product must go beyond the consumer's expressions on the subject and anticipate wants that are still latent. The difficulties of using an engineering approach to a problem with so many intangibles has led many companies to dependence on the genius or intuitive sense of "stylists." This new profession has the usual quota of quackery found in any new field. But those who have really achieved significant and consistent success in designing salable products have generally used methods not at all inconsistent with the engineering approach.

TRENDS IN MODERN LIFE RESPONSIBLE FOR CHANGES IN DESIGN AND USE OF PRODUCTS

There are certain underlying trends in American life that account for many of the recent changes in design and use of products. The accelerated tempo of modern life indicates that changes that save time will be successful. The tendency toward apartments and smaller homes indicates a desire for greater compactness. The successful designer must be thoroughly conversant with

these and similar basic tendencies of modern life. In many cases we encounter rather definite "style cycles" which influence first one industry, then another. The cycle of color, which ran the gamut of industry, first making itself felt in vivid, not to say livid, hues and later developed into soft pastel harmonies, is a case in point. The designer, then, must also be keenly alive to developments in other industries; and he must be sufficiently imaginative and ingenious to see the significance of these developments in relation to his own problems.

From the consumer much can be learned in indirect fashion. Probably nothing is quite so satisfactory as periodic field visits by those actually concerned with design problems to observe the product under conditions of actual use. The day has passed when a range can be designed by a man who has never been in a kitchen, and who does not know conditions in the modern household. It is fairly common practice in designing industrial machinery to study the operator's movements. The same technique is equally applicable to household equipment, although utilized only by a few leaders in the industry.

Much can be done at smaller expense by providing for the systematic collection and analysis of customer complaints and criticisms. These can be gathered from salesmen and dealers, and can be used as a basis for eliminating or improving those features of the product which furnish sales resistance. A few concerns have carried this somewhat farther in collecting reports of lost sales, with reasons why customers refused to buy. These tend to direct the spotlight of attention to those features of the product which in the consumer's eyes are inferior to competitive articles.

CONSUMER ACCEPTANCE THE ACID TEST OF A DESIGN

The acid test of a design, of course, is consumer acceptance. Realizing the inadequacy of our present designing technique, there is a tendency, which is becoming increasingly important, to test designs before putting them into general production. This tendency takes two forms. In some cases samples of proposed designs are submitted to representative groups of consumers and they are asked to indicate their order of preference. Provided sufficiently large and representative groups of consumers are consulted, this procedure furnishes valuable results. More conclusive information is obtained by actually putting contemplated designs on sale in representative localities. In many cases producers short-cut this procedure by asking the opinions of their dealers on proposed designs. This is cheaper and quicker, but it involves the danger that the dealer may not accurately sense the requirements of his customers.

The foregoing statements apply mainly to manufacturers of products sold to the ultimate consumer. The maker of industrial goods, machinery, accessories, parts, etc., also has his problems of product design. The need to anticipate his customers' wants is perhaps not so urgent, but the ability to help in planning is becoming a valuable sales asset. The market for industrial machinery depends on the demand for the products of that machinery. Changes in the design of the product sold to consumers mean, very likely, changes in the machinery that makes the product. The machinery manufacturer who can sense coming changes in design of the products made with his machinery enjoys a very decided time advantage over his competitor who waits until his customers bring their problems to him. Even the producer serving the industrial field, then, has a very material interest in watching the trends of consumer demand and translating those trends into the design of his products.

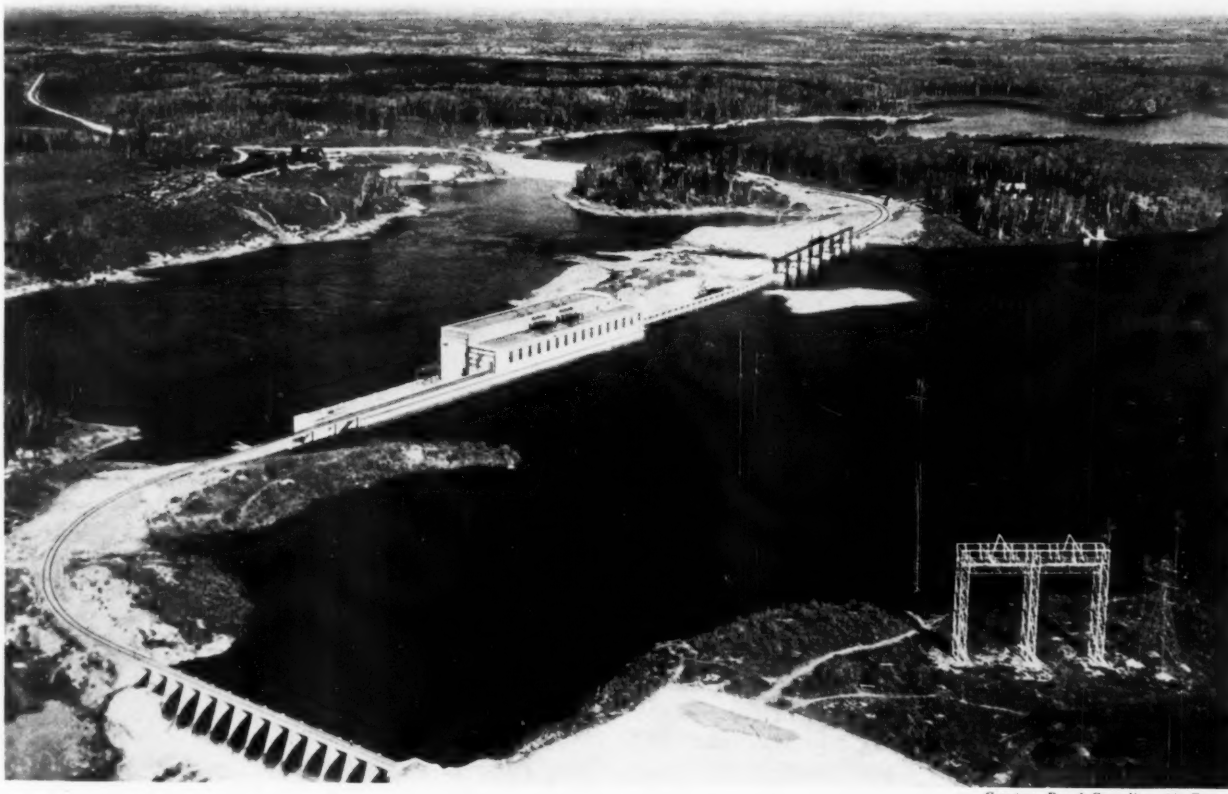
Competition has a way of equalizing itself on nearly every plane. The producer who has his industry's lowest-cost plant today can be sure that tomorrow some one else will build a plant that will operate more cheaply. The man with the best sales force will find that his competitors can soon match him. Advertising space and talent are for sale on the open market. As competitive factors tend to be equalized the emphasis comes more and more on to price—and competition based on price alone is ruinous. Practically the only way in which a manufacturer can today maintain a unique advantage over his competitors is in the design of his product. To enjoy this advantage he must excel in the ability to understand the latent wants of his customers and to translate those wants into terms of his product.

Design is fundamentally an engineering problem. It cannot, if maximum efficiency is desired, be delegated to persons unacquainted with production machinery and processes. Still less, however, can it be left to those who fail to realize the problems and needs of the consumers, from whom profits must in the last analysis come. The ideal solution is the development

(*Continued on page 565*)

Jeannette Griffith

AMONG OTHER THINGS PRODUCT DESIGN MUST RECOGNIZE GREAT VARIETY IN THE INDIVIDUAL TASTES OF BUYERS



Courtesy Royal Canadian Air Force

AERIAL VIEW OF SLAVE FALLS DEVELOPMENT ON THE WINNIPEG RIVER

HYDROELECTRIC DEVELOPMENT *in* CANADA

By T. H. HOGG[1]

IT IS PROPOSED, in this paper, to discuss the present status of hydroelectric power development in Canada, to outline the attitude toward governmental supervision and control in various parts of the country, and to describe briefly some of the outstanding features of recent large developments.

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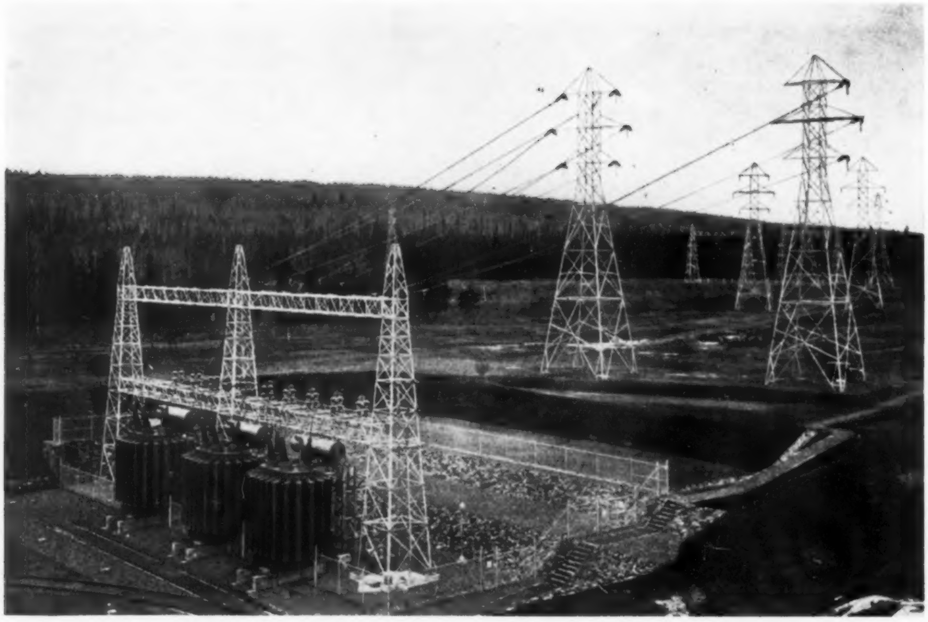
Contributed by the Hydraulic Division and presented at the Semi-Annual Meeting of The American Society of Mechanical Engineers, Bigwin Inn, Lake of Bays, Ontario, Canada, June 27-July 1, 1932. Abridged.

Large additions to the country's turbine installations came into service during the past year, and the current year will see further increases. New developments in 1931 account for a net gain in turbine installation of 540,000 hp, a figure only twice exceeded in other years, and the total development amounted to 6,666,000 hp at the end of that year. This figure has been reached by a more or less steady growth since the beginning of the century, somewhat accelerated in recent years, and, while paralleled by similar growth in other countries, represents a larger per capita development than



OUTDOOR TRANSFORMER AND SWITCHING STATION, ALEXANDER POWER DEVELOPMENT ON THE NIPIGON RIVER

exists in any other country except Norway. The growth total development in Canada in 1900 amounted to less than 200,000 hp, had grown to 1,000,000 hp in 1910, to 2,500,000 in 1920, and at the present time is twice as great as it was in 1924. This total is made up of 2,700,000 hp in Quebec, 2,100,000 hp in Ontario, 600,000 hp in British Columbia, over 300,000 in Manitoba, and the remainder in the other five provinces.

Attention must be drawn to those conditions which have promoted intense hydroelectric development in the central portion of the country. The provinces of Ontario and Quebec are devoid of coal deposits and therefore dependent for their fuel supplies upon importation from the states immediately south of the international boundary, or upon the mines of Nova Scotia in the extreme East, or of Alberta in the West. The costly long rail haul from either of these sources has resulted naturally in the bulk of coal supplies for the central provinces being drawn from Pennsylvania, Ohio, and West Virginia. When transportation charges from these relatively nearby sources are added, the cost of energy produced from the fuel becomes a serious burden on industry.

Canada's manufactured products have a gross value almost twice as great as its agricultural products, and greater than the total value of products of all primary industries (agriculture, forestry, mining, fisheries, etc.). In 1928 the gross value of products manufactured in Canada amounted to $3,769,850,364, and 80 per cent of these products came from Quebec and Ontario. Thus these provinces, in spite of their lack of fuel supplies, are the principal seat of industries in which in most countries fuel is one of the essential raw materials. This pre-eminence is explained in part by the availability of hydraulic power, and on the other hand explains the very extensive development of hydroelectric energy in this area.

PHYSICAL CONDITIONS PROMOTING DEVELOPMENT

This extensive development of hydraulic power has been promoted, as has been indicated above, by large demands for industrial, commercial, and domestic power in a district devoid of fuel supplies. Physical conditions, however, must be such that the potentiality of the streams can meet the demands.

The maximum elevation in Ontario is only slightly above 2000 ft, and in Quebec the mountain ranges lack by far the extent and altitude of the ranges in the Atlantic states or the western part of the continent. Developed heads are therefore moderate, relatively few exceeding 200 ft. Wide distribution of available sites compensates for lack of greater concentrations of head.

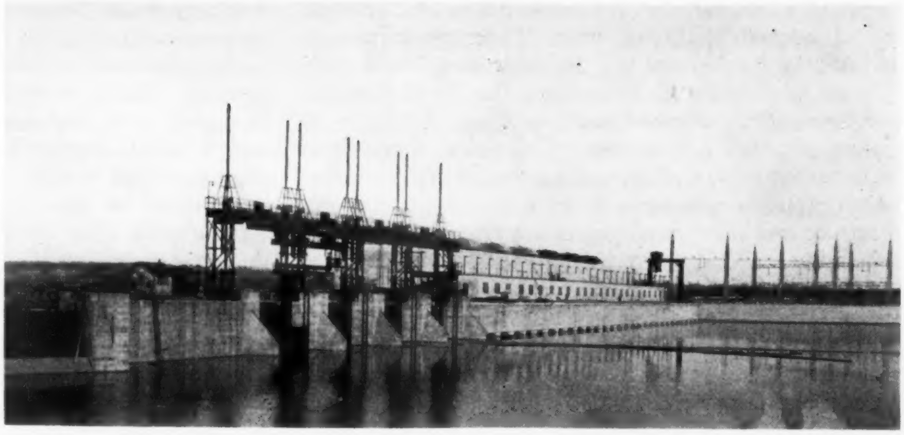
Stream-flow regimen differs materially from that existing in rivers elsewhere on the continent on which large developments exist. Precipitation in Ontario and Quebec is less than in the region to the south of the Great Lakes, and decreases somewhat as one proceeds northward. The distribution throughout the year is fairly uniform, but heaviest in the winter months as one approaches the seaboard, and in the summer months toward the northwest. Intense precipitation resulting in high flood stages is seldom experienced, and, in general, the ratio of low to average flow is high. Innumerable lakes of all sizes, widely distributed, serve to further improve the natural distribution of the run-off, and in some instances artificial control of lake expanses has effected practically perfect regulation of the rivers. The natural regulating effect of the lakes probably plays a greater part than any other single factor in making the rivers of the central provinces such important power sources.

GOVERNMENTAL CONTROL

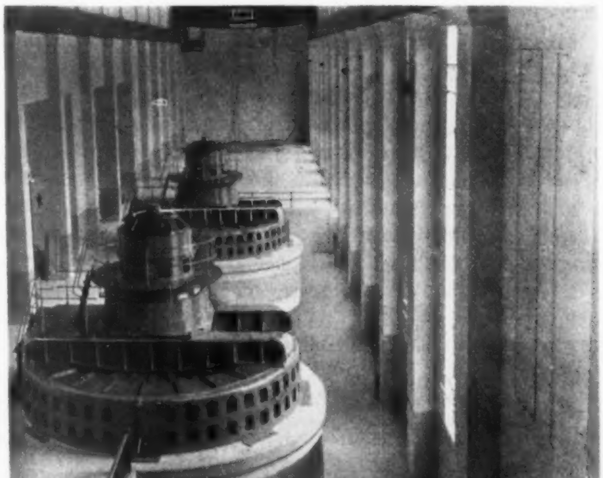
As with other natural resources, control of water-power development rests with the provinces. The nature of the control that is exercised varies. In four provinces, hydroelectric power commissions operate. In the province of Quebec, the Quebec Streams Commission makes recommendations as to control of water resources, and has constructed and operates storage works on a number of rivers. In British Columbia there is no provision for development except by private

agency, but in all provinces, including those in which power commissions exist, provision is made for the issuance of licenses for development by other than governmental agencies.

A brief account of the events that have culminated in the extensive publicly owned system in Ontario will be of interest. It became evident in the early years of the century that hydroelectric development would become a key industry, and interest in this in Ontario was developed by the expanding manufacturing development and the inception of construction work on three large power plants at Niagara Falls. In 1903, seven municipalities united in an investigation of the transmission possibilities of Niagara power and other related subjects, by the appointment of the Ontario Power Commission under enabling legislation passed by the Provincial Parliament. This commission published a comprehensive report in 1906, which resulted in the passage by the Provincial Government of the Act creating



SLUICE GATES AND HEADWORKS, CHATS FALLS DEVELOPMENT ON THE OTTAWA RIVER
(Head water about 10 ft below normal level.)



INTERIOR OF GENERATING STATION, SLAVE FALLS DEVELOPMENT
(Note compact arrangement and absence of auxiliary apparatus.)

the Hydro-Electric Power Commission of Ontario. In 1908, by-laws were passed by thirteen municipalities authorizing their officials to make contracts with the Commission for a supply of electrical power. Transformer stations and transmission lines were built, and power, purchased from the Ontario Power Company, was distributed first in 1910. The initial load of 1000 hp grew quickly, and now amounts to over 1,300,000 hp, generated mainly in plants owned by the Commission.

The basic conception of the whole electrical undertaking controlled by the Commission is that it is a partnership of municipalities formed to obtain power at cost, each municipality paying its share of the cost for the service received.

The partnership now comprises over 550 municipalities, of which about 325 are urban municipalities and 225 are townships. The local distribution of electrical energy within the borders of each municipality is, in general, under the administration of a public-utilities commission appointed by the municipality.

Provision is also made for the issuance of licenses for power rights on rivers to private corporations. One of the large developments now proceeding, which comes in this group, is that of the Ontario Power Service Corporation on the Abitibi River, to which reference is made later. Private enterprise controls plants in the province generating over 1,000,000 hp, which is used in industrial plants directly, or distributed to consumers through some twenty independent transmission systems.

In Quebec, private enterprise has been looked to for the supply of electrical energy. Active assistance is provided by the Quebec Streams Commission, which "is authorized to ascertain the water resources of the province, to make recommendations regarding their control, and to construct certain storage dams and operate them so as to regulate the flow of streams."

Three other provinces have hydroelectric power commissions similar in most respects to the Ontario Commission, viz., Nova Scotia, New Brunswick, and Manitoba. In the last-named province also, the city of Winnipeg has its own hydroelectric system, with power developments on the Winnipeg River at Point du Bois and Slave Falls.

THE PULP AND PAPER INDUSTRY

The pulp and paper industry has had a growth paralleling the growth of hydroelectric power. The

output of wood pulp in 1910 amounted to 475,000 tons, and in 1929 to 4,021,000 tons. Paper production in the latter year amounted to 3,200,000 tons. Its development has been due to the existence in Canada of abundant water-power resources adjacent to extensive forest resources of pulp-wood species. The power demands of the industry are large, approximately 100 hp per ton of daily output of newsprint being required. Continuity of service and low-priced power are essential factors in economic operation.

In many instances, pulp and paper companies generate power for their own use in close proximity to their mills, the pulp and paper industry itself having a total installation of over 600,000 hp, and additional hydroelectric energy is purchased to operate motor installations aggregating over 990,000 hp. The total power used in the industry is thus in excess of 1,500,000 hp, and of this 82 per cent is hydroelectric. The bulk of the production of pulp and paper is in the central provinces. Quebec produces about 56 per cent of the total, and Ontario, 34 per cent.

TURBINES

Reference has already been made to the constancy of flow of the rivers in the central part of the country particularly, and to the fact that developments under moderate heads are in the majority. A third factor, along with these, has had a great influence in determining the type of turbine equipment commonly used, namely, that isolated plants are rare and interconnection between extensive transmission systems is common. Under these conditions most Canadian plants of large size are equipped with Francis-type turbines of moderate specific speed, or those of the propeller type of high specific speed with fixed blades. In a few instances, on account of some special condition as to variation of head and flow, turbines with manually adjusted blades have been used. There are only two small installations of Kaplan runners in the country.

Francis turbines of moderate specific speed perform advantageously at part load, and give high efficiency at and near full load. The more recently developed fixed-blade-propeller-type turbines reach maximum efficiency nearer maximum capacity than the Francis turbines. Kaplan turbines (that is, with governor-operated blades) perform excellently on part load, but do not reach the high maximum efficiency of the fixed-blade-propeller turbine. Hence most of the Canadian plants are equipped with moderate-sized turbines, of the Francis and fixed-blade-propeller types, which, with interconnection of systems, constancy of river flow, and multiplicity of units, effect high generating efficiency. At the same time there is less hazard of seriously reducing the capacity of a system with units out of service, as would be the case were units of the greatest feasible capacity used.

Propeller turbines, of the largest size under heads greater than in use elsewhere for this type, were installed first in Canada, and have led the way to their adoption under still higher heads in other countries. The installation of 33,000-hp units, having a specific speed of 131 under a head of 60 ft, at La Gabelle is a case in point. The Kaplan-type turbine has so far only been used for smaller installations where high kilowatt-hour output under very variable head and water conditions is essential. Certain of the larger medium-head stations, where Francis or propeller-type units are installed, are provided with additional space, which will be utilized for installation of Kaplan turbines whenever the demand warrants it.

Table 1 gives general data regarding a number of recent important developments.

Scroll casings, molded in concrete with improved elbow-type draft tubes, are usual for heads up to 90 ft. For gates, runners, and seal rings, the material used is in general a good grade of cast iron, cast steel, and plate steel. Bronze is now seldom used. The chief reason for the change in attitude regarding selection of materials is the progress that has been made in the art of electric welding, whereby such materials as stainless steel and other anti-rusting alloys may be used for the repair of eroded surfaces. Parts subjected to rapid erosion can be coated with anti-rusting material, and, with reasonable care, maintenance work has been reduced considerably. Most of the Canadian power corporations have been successful in repairing eroded cast iron to such a degree that almost continuous service is secured without expensive replacement.

TABLE 1 DATA ON RECENTLY BUILT CANADIAN HYDROELECTRIC DEVELOPMENTS

Development	River	Head, ft	Hp per unit	Speed, rpm	Specific speed	No. of units installed	Horsepower Installed	Horsepower Ultimate
Alcoa Power Company	Saguenay	150	65,000	120	58	4	260,000	260,000
Montreal Island	Back River	26	12,000	85.5	160	6	72,000	120,000
Beauharnois	St. Lawrence	80	53,000	75	73	4	112,000	636,000
Chats Falls	Ottawa	53	28,000	125	146	8	224,000	280,000
La Gabelle	St. Maurice	60	33,000	120	131	5	165,000	165,000
High Falls	Lièvre	180	30,000	180	47	3	90,000	120,000
Masson	Lièvre	185	34,000	166.7	45	4	136,000	136,000
Abitibi Canyon	Abitibi	240	66,000	150	42	5	330,000	330,000
Alexander	Nipigon	60	18,000	100	81	3	54,000	72,000
Great Falls	Winnipeg	56	28,000	138.5	128	6	168,000	168,000
Slave Falls	Winnipeg	30	12,000	94.7	148	2	24,000	96,000
Seven Sisters	Winnipeg	66	37,500	138.5	143	3	112,500	225,000
Ghost	Bow	108	18,000	150	60	2	36,000	54,000
Corra Linn	Kootenay	53	19,000	85.7	82	3	57,000	57,000

The structural design in general employed at medium-head plants is the open-type or separate-stay-vane construction. This has many advantages in setting, removal of internal casting stresses, and easy handling in shops and field. Another advantage is gained in tying together the turbine structure and reinforced concrete, whereby the whole setting acts as a homogeneous unit in resisting the stresses induced by high-water pressure on large areas.

Wheel pits, head covers, bearings, and auxiliary equipment have undergone simplification, and one is sometimes amazed at the clean appearance of recently built power houses in comparison with older plants in existence.

For higher heads, the use of the spiral casing as a housing for the turbine parts still prevails; however, instead of cast iron or even cast steel, riveted steel plate constructed in circular shape as a continuation of the penstock is mostly used.

For a number of years it was thought very important that specially designed draft tubes be constructed to give the proper diffusing effect and thus increase the efficiency of the turbines. In a number of instances rather unpleasant experiences have been encountered, and alterations were made with corresponding improvement of output and efficiency. Recent installations with comparatively short elbow-type draft tubes, and even with short, straight-cone-type plate-steel draft tubes, have given in test excellent results as to efficiency and general performance when combined with high-specific-speed runners under relatively high head. More recent practice shows the adoption of improved elbow-type draft tubes with a fairly long horizontal element, thus reducing the high velocity in an unrestricted channel to a low velocity in the actual tailrace.

Turbine bearings are made in various forms. So far, preference has been given to the lignum-vitae water-lubricated type, and in recent installations water-lubricated rubber-lined bearings are being used with good results. For lubrication of the moving parts in the turbines, industrial alemite grease lubrication is used in nearly all plants.

GOVERNORS AND GOVERNING SYSTEMS

The governors in use in all recently built plants fall into two classes: first, those with light, sensitive flyballs and compensating devices to which every conceivable automatic control feature is readily applicable; and, second, those with heavy flyballs, highly sensitive compensation, and quick-acting servomotor control. While there is variety in design and appearance, these all follow the same principle in performance. The pressure medium used in servomotors to move the gates is usually oil of fairly high viscosity.

Pumps are now invariably of the gear type, direct connected to electric motors. The pumping rate is controlled by unloader valves, pressure-limit valves, and float-controlled valves, thus eliminating unnecessary oil circulation under high pressure and wastage of power. The recent trend has been toward reducing the pumping capacity by the adoption of larger pressure tanks, thus also eliminating unnecessary heating of the oil.

Central pumping plants, so often favored, have been superseded largely by the so-called "two-unit pumping system." This system is applicable to power plants where four or more units are installed. The governors and pressure units are interconnected in pairs, and so proportioned that one pump, including the tank equipment, can handle the servomotors of two units. In this respect the two recent installations of large size, at Beauharnois and Chats Falls, are similar.

Reference should be made here to a new departure in flyball drive for governors which promises to overcome certain objectionable features of the electric drive. This is the adoption of a permanent-magnet generator mounted on the turbine shaft, furnishing power for the flyball motors independently of any other source of power, and unaffected by any changes except changes in speed of turbine shaft.

TYPICAL DEVELOPMENTS

Beauharnois Development. This development, on the St. Lawrence River in Quebec, takes advantage of the difference of 85 ft in level of Lakes St. Francis and St. Louis, two of the expanses on the river. The water supply for the power house is drawn through a power canal 15 miles long and 3000 ft wide, formed largely by dikes, the natural ground surface being below the Lake St. Francis level, except close to the intake. The power house is located across a portion of the lower end of the canal close to Lake St. Louis. Provision is made for the installation of twelve units of 53,000 hp each, and these, under the operating head of 80 ft, are of exceptional size. The units run at 75 rpm, and have a specific speed of 73. It is interesting to compare the turbines of this development with those at Cedars Rapids nearby—in their day the largest turbines built so far as physical dimensions were concerned. Those at Cedars have a capacity of 11,300 hp and operate at 54.3 rpm under a head of 30 ft. Their specific speed is 83, and the runners are 16 ft $2^1/_2$ in. in diameter, as compared with 18 ft for the Beauharnois units.

Chats Falls Development. This development is located on the Ottawa River, about 35 miles upstream from the city of Ottawa, and is connnected by a 220-kv transmission line over 200 miles long to the Niagara system of the Hydro-Electric Power Commission at Leaside. Four units are installed and operating, and four more are nearing completion. Two additional units will complete the installation. The plant operates under a head of 53 ft. The turbines have a rated capacity of 28,000 hp each at 125 rpm, and are of the propeller type, having a specific speed of 147. Units of this type have a high efficiency at or near maximum capacity which is not well sustained at part loads. They exceed turbines of the Kaplan type in maximum efficiency, but are of course much less efficient at part gates. Their installation in such plants as that at Chats Falls is amply justified, since there are a large number of units in the plant, the minimum flow of the river is well sustained, and

the plant is part of a large interconnected system. It is thus possible to operate units always at or near full gate, and thereby gain full advantage of the high efficiency of these turbines when so operated.

Alexander Power Development. This development on the Nipigon River came into service late in 1930. Three units are installed here, the turbines being rated at 18,000 hp under a head of 60 ft. Features of interest in connection with the development are the large semi-hydraulic earth-fill dam and the elimination of sluiceways of any kind for the discharge of flood water. A concrete spillwall, 525 ft in length, has a discharging capacity in excess of the maximum river flow anticipated.

A feature of this plant, seen also in the Chats Falls Development on the Ottawa River, is the elimination of the headworks superstructure. The headgate hoists are protected by a low housing. Openings in the headworks deck, to allow the placing or removal of emergency gates and racks, are protected by close-fitting removable plant covers, and a locomotive crane, available for service elsewhere also, is provided for the service usually performed by a traveling crane. Winter-weather conditions at this plant are usually severe, temperatures 20 to 40 deg below zero being frequently experienced. To cope with these low temperatures, provision is made for the admission of warm air from the power house to the space below the headwork deck. The two winters during which the plant has operated have been milder than usual and no ice trouble has been experienced, but the weather was sufficiently severe to test and prove the efficacy of the protection provided.

Complete plant tests were made here in March, 1931, turbines, generators, and governors all being investigated. The turbine tests were carried out by the Gibson method.[2] The maximum turbine efficiency shown by the tests was 92.8 per cent.

Chute a Caron Development. The Saguenay River has characteristics similar to those of the Nipigon and Ottawa. Lake St. John, on this river, having an area of 350 square miles in its natural state, provided a high degree of regulation, the ratio of high to minimum flow being about 16. The lake is now regulated by dams at the outlet. The Chute a Caron Development, on this river, illustrates a tendency toward units of very large capacity. The head developed is 151 ft, and the units have a capacity of 65,000 hp under this head at 120 rpm. The scroll cases are of heavy steel-plate construction, varying from $1^1/_4$ in. to $^3/_4$ in. in minimum thickness, with an inlet diameter of 17 ft 6 in. They are completely enclosed in concrete.

Construction difficulties in connection with this development were unusually great. At the dam site, the Saguenay flows in a narrow gorge, where the depth of water was 65 ft in times of lowest flow. Control of water during construction involved the diversion of the whole river flow through an artificial channel.

Winnipeg River Developments. On that part of the Winnipeg River between Point du Bois and Great Falls, a distance of about fifty miles, there are now four major power developments, all of which contribute to the power requirements of the city of Winnipeg and the surrounding district. The river flows into Lake Winnipeg, about seventy miles northeast of the city of Winnipeg, and drains large areas in Ontario, Manitoba, and Minnesota. Included in its tributary areas are Lake of the Woods, Rainy Lake, and Lac Seul, all of which are regulated.

The four developments that are referred to above are the two municipally owned plants of the Winnipeg Hydro-Electric System at Point du Bois and Slave Falls, the 168,000-hp development of the Manitoba Power Company at Great Falls, and the 225,000-hp development of the Northwestern Power Company at Seven Sisters Falls.

The progress in the development of the hydraulic turbine and in power-house layout is exemplified by these plants. The Point du Bois plant is equipped with sixteen units, the first of which, installed in 1911, was of Swedish design, with a horizontal double runner, and of 5200 hp capacity. The Great Falls plant contains 28,000-hp propeller units having a specific speed of 128 and operating under a head of 56 ft, the first being installed in 1922. The selection of such units at that time was decidedly bold. The later plants at Slave Falls and Seven Sisters also have propeller units, but of higher specific speed, and those at Seven Sisters Falls are of unusual capacity and head for this type, viz., 37,500 hp under a head of 66 ft. The Slave Falls plant exemplifies to a wonderful degree simplicity of design, as will be seen from the illustration shown of the generator room.

POWER-HOUSE LAYOUT

The trend toward simplification in design and layout, already referred to, has extended in all directions. Many stations now contain nothing but low-voltage equipment, the transformation and high-tension switching being separated from the generating portion of the development. The transformation and high-tension switching is of course unhoused in such cases, even in situations where very severe winter conditions are experienced. This arrangement is to be found most frequently at low- and medium-head developments. When, on account of increased head, greater space is necessary between headworks and generator room to provide stability or satisfactory water passages to the turbines, the high-tension equipment is frequently located to take advantage of the foundation provided by the part of the substructure occupying this space.

It is quite evident, from a comparison of old and recent power-house cross-sections, that a reduction has been effected in power-house width. The interior view of the Slave Falls station and the cross-section of the Chats Falls power house both show this reduced width. The latter cross-section also shows the long horizontal section of draft tube extending far beyond the downstream power-house wall.

[2] See Trans. A.S.M.E., vol. 45 (1923), p. 343.

The Measurement of SURFACE TEMPERATURES

Accuracies Obtainable With Thermocouples

By NEIL P. BAILEY[1]

THE accurate determination of the temperature of a solid surface is a very common problem that confronts any engineer who is conducting thermal tests or experiments. Investigations of heat conduction, convection, and radiation; heat runs on mechanical and electrical machinery; and tests of heating equipment, all require the accurate measurement of surface temperatures. Such determinations are made in a great variety of ways, ranging from a mercury thermometer fastened to the surface in ordinary commercial testing to the very elaborately embedded thermocouples used in precise experimental work.

There are in general three common sources of error in all methods. (1) If the measuring element is merely held against the surface, the gas film between the element and the surface is not eliminated, and the heat flow between the surface and the element will cause a temperature drop. (2) Even though this source of error is eliminated, if the cross-section of the measuring element is large, the heat conduction along the element may introduce a large error. (3) If the measuring element has appreciable exposed area and the surroundings are not at the same temperature as the surface, the heat radiated may cause considerable error.

Most investigations of surface-temperature measurement have been concerned with the adaptation of thermocouples to eliminate these three sources of error, and when the thermocouples can be embedded directly in a metal surface, very accurate results can be obtained.[2,3] However, temperatures of nonmetallic surfaces are quite often desired, and even when the surface is metallic it is not always feasible to embed the couples. Also, thermocouples have by no means replaced mercury thermometers in commercial testing for surface temperatures, so that it seems highly desirable to know quantitatively the limits of error involved when determinations are made by fastening thermometers and thermocouples to surfaces in different ways.

The variables that were studied experimentally in this paper may be classified as follows:

1 Effect of thickness of thermometer covering
2 Effect of type of thermometer
3 Effect of covering materials used
4 Effect of surface position, whether vertical or horizontal
5 Effect of construction of thermocouples.

In all of the experiments carried out the surface was at a higher temperature than the surrounding air, and there was no forced circulation of the air.

EXPERIMENTAL METHODS

Before any information concerning the accuracy of the various methods of surface-temperature measurement can be had, it is necessary to know positively the true surface temperature. The work of W. F. Roeser and E. F. Mueller[2] and of I. B. Smith[3] indicates that if the two wires of a thermocouple are peened into small holes in a metal surface, the errors due to film resistance are eliminated; and then if the wires are carried away in milled grooves for a distance, care being taken that they are insulated electrically from the surface, the error due to conduction along the wire is eliminated. In general, though, until a method has been carefully checked, any determination of surface temperature made on only one side of a plate through which heat is being transmitted, will always be in doubt. However, this difficulty was overcome with the apparatus shown in Fig. 1. Briefly, the idea used was as follows: A metal plate was so arranged that the rate of heat flow through it per unit area was known. Knowing the thermal conductivity of the metal, the actual temperature difference between the two sides could be calculated. Now suppose the surface-temperature readings were determined for the two sides. If these readings were correct the difference between them should be equal to the previously calculated temperature drop across the plate. If such a check is not satisfied, it is then definitely known that true surface temperatures are not being read.

The apparatus shown in Fig. 1 consisted of an electric heater between two wrought-iron plates, with the heater wound so that the heat loss per unit area of plate would be constant. The plates and the asbestos-paper sheets used on the two sides of the heater were respectively alike in size and material, so that when the apparatus was put in a vertical position, and no stray air currents were present, the heat loss would divide equally between the two plates. To eliminate surface-temperature drop, instead of fastening thermocouples to the two sides of the plate, No. 28 gage constantan wires (1 and 2) were welded directly to one of the plates as shown, and a similar wire (3) was welded to a long projection from that plate. This projection was worked down to a small cross-section, and the cold junction was maintained at 32 F by immersing several inches of it in ice.

This arrangement made wires 1 and 3 and the plate into a wrought-iron, constantan couple for measuring the plate's outside surface temperature, and wires 2 and 3 and the plate constituted a couple for measuring its inside surface temperature. It is known[4] that such an arrangement is affected only by the plate temperature at the point where the constantan wire is welded and is independent of the temperature of the plate at any other point. A carefully checked calibration

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[2] "Measurement of Surface Temperatures," by W. F. Roeser and E. F. Mueller. *Journal of Research*, U. S. Bureau of Standards, vol. 5, pp. 793–802.

[3] "Applications and Limitations of Thermocouples for Measuring Temperatures," by I. B. Smith. Trans. A.I.E.E., 1923, pp. 349–357.

[4] "Response of Thermocouples," by Neil P. Bailey. MECHANICAL ENGINEERING, November, 1931, pp. 797–804.

curve was made for a thermocouple of constantan wire and a strip of wrought iron from the plate, using a standardized iron-constantan couple for comparison. All readings were taken by a millivoltmeter and were corrected for instrument and wire resistance.

For accuracy in calibrating or using thermocouples, it is very important that the cross-section of the elements be very small, particularly if gas temperatures are being determined. If this is not the case, the element will conduct heat away so rapidly that there will be a large temperature drop between the gas and the hot junction. As a rather extreme example of such an error, if a thermocouple constructed of No. 20 gage constantan wire and a wrought-iron bar $^1/_4$ in. by $^1/_2$ in. in cross-section is immersed 6 in. in gas at a temperature of 500 F, the

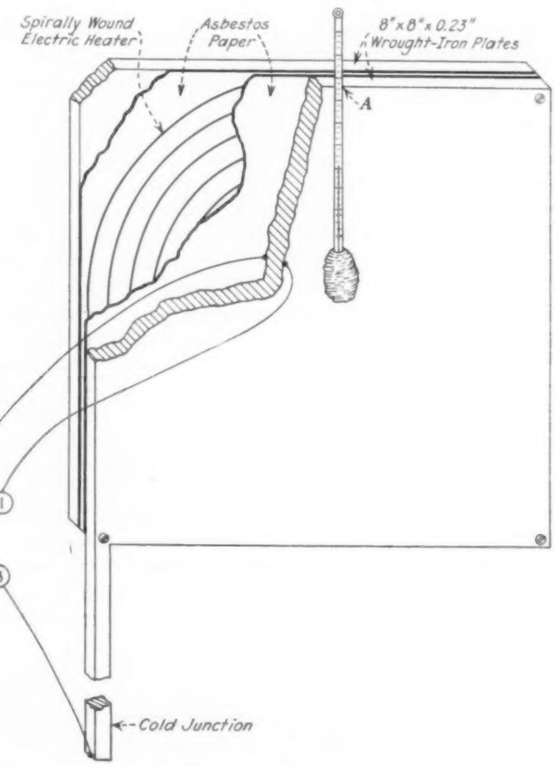


FIG. 1 HEATER PLATE FOR USE IN MAKING SURFACE-TEMPERATURE TESTS

(1, 2, and 3 are No. 28 gage constantan wires welded to the wrought-iron plate.)

remainder of the couple being subjected to a room air temperature of 75 F, the thermocouple will indicate a temperature of only 370 F. To eliminate such errors in the calibration of the constantan, wrought-iron couple, No. 20 gage wire was used in both the standard and test couples, and the wrought-iron element was worked down to the same size as the wire.

By welding wires 1, 2, and 3 directly to the plate and using the plate as a thermocouple element, it was hoped to read the true surface temperatures, but this did not prove to be exactly the case. When the heat loss from the electric coil was 880 Btu per hr per sq ft of plate surface, couple 1–3 indicated an outside temperature of 306 F and couple 2–3 an inside temperature of 312 F. Taking the thermal conductivity of wrought iron as 34 Btu per hr per ft cube per deg F and a thickness of 0.23 in., gives a temperature drop through the plate of 0.124 F, which is entirely negligible. From this it is evident that the indications were being affected by the hot gas on the inside and the cooler air on the outside.

Assuming, as an approximation, that the error was equally divided between the two sides would indicate that couple 1–3 read a temperature 3 deg less than the outside temperature and couple 2–3 a temperature 3 deg higher than the inside surface temperature. This would give a surface temperature of 309 F. Presumably there remains a surface of high heat resistance even when the wire is welded to the plate, so that the heat conducted away by the wire causes the temperature of the actual surface of contact to be less than that of the surrounding surface on the outside, and greater than that on the inside. To check this, the weld of No. 1 was covered with $^3/_{16}$ in. of an asbestos-oil paste for the above condition, and it then indicated a temperature of 308.5 F, verifying the previous average of 309 deg. To further check this method of obtaining the true surface temperature, two No. 20 gage constantan wires were attached in a manner similar to that employed with the No. 28 gage wires 1 and 2. When the small wires indicated inside and outside temperatures of 324 deg and 317 deg, respectively, the large ones gave 326 deg and 315 deg. This was a discrepancy of 11 deg for the large wire as compared with 7 deg for the small one. However, the average of 320.5 was the same in both cases. After many such checks as the foregoing had given consistent results over a wide range of temperatures, it was decided that

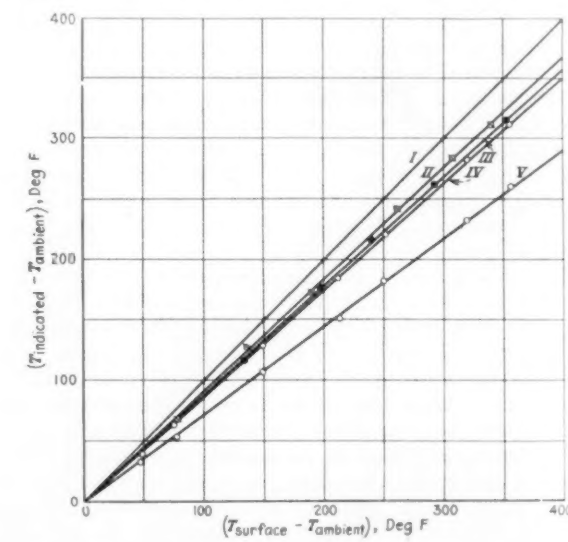


FIG. 2 EFFECT OF THICKNESS OF THERMOMETER COVERING ON INDICATED SURFACE TEMPERATURE

Asbestos-paste covering; ambient-air temperature, 75 F
Curve I—Surface temperature
Curve II—$^3/_8$-in. covering
Curve III—$^3/_{16}$-in. covering
Curve IV—$^3/_{32}$-in. covering
Curve V—No covering

the average of the indications of the thermocouples 1–3 and 2–3 could be taken as the true surface temperature, with a probable error of one or two degrees at the most.

TEST RESULTS

With a method of determining the true surface temperatures established, attention was directed to the ordinary mercury thermometer as a means of measuring surface temperatures. Since the bulb of the thermometer is usually placed in contact with the surface and then covered with some insulating material, the first thing studied was the effect of the amount of this insulating material used.

Effect of Thickness of Thermometer Covering. By repeatedly covering thermometers with both putty and with an asbestos-oil mixture as one would ordinarily attach a thermometer, it was decided that approximately $^3/_{16}$ in. of covering is the most probable ordinary thickness used, and this was taken as a standard. A thickness of $^3/_{32}$ in. gives the thermometer a decidedly bare appearance, and one of $^3/_8$ in. is rather difficult to keep in place.

With the plate in the vertical position tests were run with these three thicknesses and with no covering, and the results are shown by Fig. 2. The difference between the surface temperature and the ambient-air temperature was plotted against the difference between the indicated temperature and the temperature of the ambient air, because it is this temperature difference and not the total temperature which causes the error. The curves of Fig. 2 show that a bare thermometer in contact with the surface reads 72 per cent of the temperature difference, $^3/_{32}$ in. of covering raises this to 87 per cent, and $^3/_{16}$ in. to 90 per cent, while $^3/_8$ in. of covering causes an indication of 92 per cent of the difference. Considering $^3/_{16}$ in. as the ordinary thickness used gives 90 per cent of the difference as the reading to be expected when using a thermometer for the determination of surface temperatures. This does not mean, however, that the error is 10 per cent. For a surface temperature of 120 deg and an air temperature of 70 deg, the error would be $^1/_{10}$ of 50 or 5 deg, which would cause an error in the determination of the total temperature of slightly over 4 per cent. In the case of a surface at 470 deg with 70-deg air, this would mean an error of 40 deg or $8^1/_2$ per cent.

Effect of Type of Thermometer. The previous tests were made using a 760-deg-F, 12-in.-long, 1-in.-immersion thermometer having a bulb $^3/_{16}$ in. in diameter and $^3/_8$ in. long. The insulation was extended to the point of immersion, and the thermometer was inclined at a small angle with the surface to keep the stem from coming in contact with it. The results obtained were compared with those given by a 400-deg-F, 14-in., full-immersion-type thermometer with a $^3/_8$-in. mercury bulb $^3/_4$ in. long, using the same thickness and total area of insulation as before. The stem of this thermometer was left in contact with the plate, and a stem correction was applied, the point *A*, Fig. 1, being considered to be the point of immersion. As shown by Fig. 3, within the limits of accuracy possible the type of thermometer used has no detectable effect on the indicated surface temperature, provided each thermometer is applied in a manner consistent with its type.

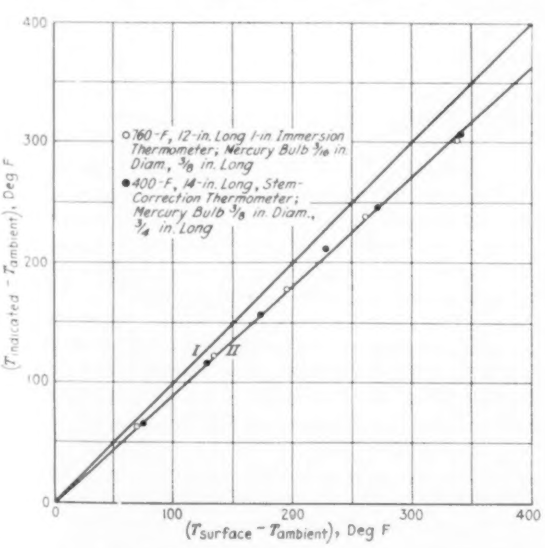


FIG. 3 EFFECT OF TYPE OF THERMOMETER ON INDICATED SURFACE TEMPERATURE

Covering, $^3/_{16}$-in. asbestos; ambient-air temperature, 75 F
Curve I—Surface temperature
Curve II—Indicated temperature.

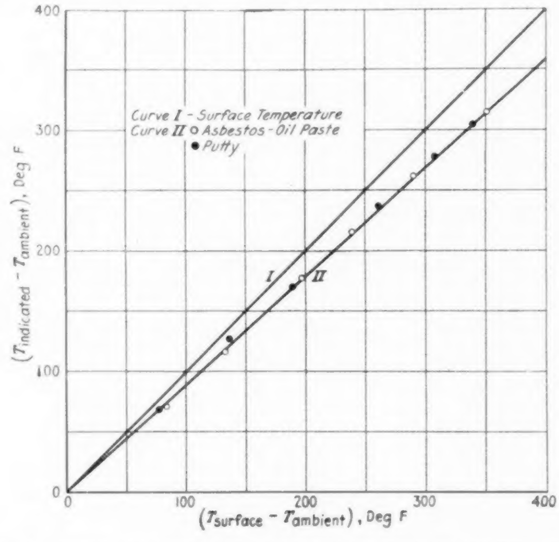


FIG. 4 EFFECT OF COVERING MATERIAL ON SURFACE-TEMPERATURE INDICATIONS OF THERMOMETERS

Thickness of covering, $^3/_{16}$ in.; ambient-air temperature, 75 F

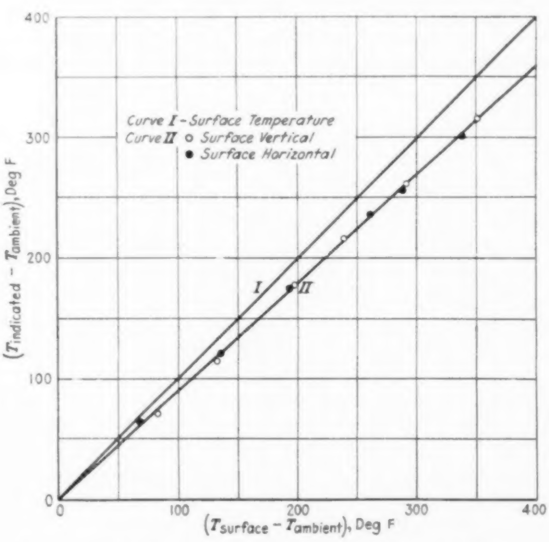


FIG. 5 EFFECT OF SURFACE POSITION ON SURFACE-TEMPERATURE INDICATIONS OF THERMOMETERS

Covering, $^3/_{16}$-in. asbestos; ambient-air temperature, 75 F

If a constant-immersion type is used, it should have the immersion length covered by the insulation and the stem separated from the surface. If a full-immersion type is used, a stem correction should be made, considering the point of immersion as that point where the stem first touches the surface.

Effect of Covering Material. The most common thermometer-covering materials used are putty and a plastic mixture of finely divided asbestos with oil. The results plotted in Fig. 4 show

them to be of equal value as far as their effect on the indicated temperature is concerned. In actual use, putty has more strength than the asbestos, but becomes very hard with prolonged use and burns badly above 350 F, while the asbestos remains soft. Mixtures of the two in various proportions are often advantageous.

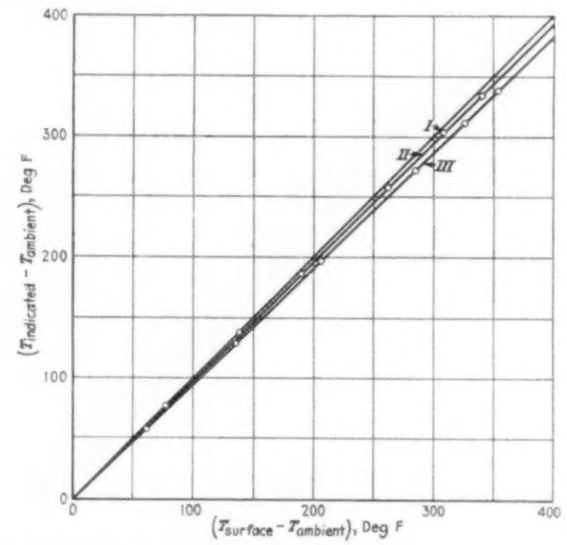


FIG. 6 EFFECT OF THERMOCOUPLE SIZE ON INDICATED SURFACE TEMPERATURE

Covering, $^3/_{16}$-in. asbestos; ambient-air temperature, 75 F
Curve I—Surface temperature
Curve II—Indication of No. 28 gage iron-constantan thermocouple
Curve III—Indication of No. 20 gage iron-constantan thermocouple.

Effect of Surface Position. Since the heat convection from a vertical surface is not the same as that from a horizontal surface, the effect of surface position on indicated temperature was studied as shown by Fig. 5; however, no difference could be detected between the two cases.

Surface-Temperature Indications of Thermocouples. Since thermocouples are very convenient to use and are widely applied in thermal testing, their reliability as indicators of surface temperature was investigated. Two sizes of iron-constantan couples, No. 28 gage and No. 20 gage, were constructed with welded junctions that were carefully made as small as possible consistent with the necessary mechanical strength. They were attached to the plate by means of $^3/_{16}$ in. of asbestos paste, care being taken that the hot junctions were placed and held firmly against the plate. The curves of Fig. 6 show that the No. 28 gage couple indicated $98^1/_2$ per cent of the temperature difference, and the No. 20 gage couple $95^1/_2$ per cent.

CONCLUSIONS

The foregoing results indicate quite clearly that thermometers do not indicate surface temperatures with sufficient accuracy for experimental work, and that when they are used in commercial testing it should be remembered that they indicate, when referred to the ambient-air temperature, approximately 90 per cent of the true difference between the surface and ambient-air temperatures.

On the other hand, when carefully made of small-gage wire and fastened to a surface with a covering of insulation, thermocouples will indicate as high as 98.5 per cent of the difference between the surface and the ambient-air temperatures. If a metal surface is being tested and the leads and junction are properly embedded or are welded on and covered with putty, accuracies close to 100 per cent may be attained.

Nikolaus August Otto

JUBILEES and centenaries follow one another so quickly nowadays that we are apt to pay them little attention; they do serve, however, to remind us of what we owe to those who have passed on before us. Especially is this so in the case of Nikolaus August Otto, the pioneer of the four-stroke cycle gas engine, the centenary of whose birth was commemorated at Cologne on Tuesday last, June 14, by the local branch of the Verein deutscher Ingenieure.

Although in the visualization of the cycle Otto was anticipated by Beau de Rochas—1862—yet to Otto we owe the practical working out of the greatest single improvement that has been made in the gas engine, the compression of the explosive mixture in the cylinder prior to ignition, whereby a dilute mixture can be fired, giving a quiet explosion and sustained pressure during the working stroke. This is only achieved with one explosion in every four strokes of the piston, but the unequal turning effort may be smoothed out by a fly-wheel. Whatever its defects, the cycle remains today the commonest one for internal-combustion engines.

Otto was born in the village of Holzhausen, in Nassau, where his father was the innkeeper and posting-master. His school education only lasted till the age of sixteen, when he left home to start a commercial career in Cologne. Newspaper reports about Lenoir's gas engine fired his imagination, and led him to the construction, with the aid of a clever mechanic, of his first "atmospheric" engine, patented between 1861 and 1864. There are still some of us who can remember that fearful and wonderfully noisy machine, with its free piston shooting up the vertical cylinder. Perhaps the most important event of this period was the happy meeting in February, 1864, of Otto with Langen, names to be associated for all time with the gas engine. The firm N. A. Otto et Comp. was established on March 31, 1864, in Cologne, with a workshop in Servaesgasse 2. Its first success was at the Paris Exhibition of 1867, where the engine got the gold medal in its class. Increasing business led to the formation in 1872, of the Gasmotorenfabrik Deutz A.G. In a corner of the shop Otto went on experimenting, and in November, 1876, one of the new "silent"—the word speaks volumes—four-stroke horizontal engines was at work. This engine is preserved in the museum of the firm, now the Humboldt-Deutz-Motoren A.G. The design was covered by the well-known German patent of August 4, 1877. At the Paris Exhibition of that year it was premiated, and set all the world talking.

By the end of 1880 upward of 2600 engines had been made by the Deutz firm alone. In England at an early date Messrs. Crossley Brothers began making the engines under license. The first English atmospheric and an early silent example are preserved in the Science Museum, South Kensington. In the United States the firm of Schleicher, Schumm and Co., of Philadelphia, was formed in 1877 to work the Otto patents in America. In France the Compagnie Française des Moteurs à Gas et des Constructions Mécaniques began business in Paris in 1879.—*The Engineer*, June 17, 1932, p. 670.

The Economics of

ELECTRICAL POWER SUPPLY[1]

By ALEX. D. BAILEY[2]

A Survey of the Sources of Electric Power Supply and of the Economics of Its Generation by Steam or Water Power, and a Discussion of the Advantages in the Use of Various Fuels, Methods of Load Forecasting, Operating Procedure, and Trends in Power Costs.

DURING the past two years the electric light and power industry has maintained its position of importance and has added to its reputation for stability, economy, and progress. Though it ranks thirteenth in the list of major industries in the value of its product and is in the same position regarding the number of employees, it is fifth when invested capital is considered. The output of electricity for 1931 is estimated by the U. S. Geological Survey at 91,500,000,000 kwhr, of which 61,500,000,000 kwhr will be generated from fuels and 30,000,000,000 kwhr from water power. Compared with the previous year (see Fig. 1) this shows a decrease of 2 per cent for that portion generated from fuels and a decrease of 9 per cent for that generated by water power. The year 1930, in turn, compared with 1929 showed a decrease of about 5 per cent for that portion generated by water power, while there was a slight increase in that portion generated from fuels. This was due to extended droughts in certain parts of the country. Fig. 1 shows the yearly power production since 1920.

Up to the year 1930, the output of electricity had shown a considerable and consistent increase from year to year. While the reports for the last two years show a recession, the industry will maintain a reasonable growth under normal conditions, as is evidenced by the continued increase in the amount of electricity used for domestic purposes during the past two years and the expanding use of electricity in rural service. In its 1930 report, the Public Policy Committee of the N.E.L.A. said: "The best judgment is that during the next ten years, to meet adequately the requirements of the nation, the output of electricity will have to be doubled."

RELATIVE INVESTMENTS IN STEAM AND WATER POWER

Although the percentage of energy produced by water power has remained fairly constant at about 36 per cent of the total, the trend, for the present at least, is, for the following reasons, toward a reduction in this amount.

As the water-power sites most readily and economically available are utilized, the cost of development of those more remote, more expensive, and less reliable will make fuel-burning stations preferable because of their relatively lower cost. The initial investment in a water-power project is usually very high, even though it may not be fully developed for some time, whereas in the case of a steam station, the construction can be carried on at a rate corresponding more nearly to load demands. The discovery of new and abundant reserves of cheap fuel also operates against the development of water power. Interconnection of systems and the resultant utilization of a common reserve of generating capacity have permitted simplifications of design in fuel-burning stations which have lowered power costs. When combined investment and operating costs are considered, the thermal cycle still offers possibilities for improvement, while the efficiency of water-power stations is probably as high as can ever be practically realized. Conversely, the interconnection of systems has in certain cases permitted the utilization of water power which could not otherwise be economically developed because of seasonal fluctuations of water supply and high cost of water storage. It is an unfortunate fact that 72 per cent of the country's water-power resources are west of the Mississippi River, while 70 per cent of its power requirements are east of that river. Table 1 gives data on the relative capacities and costs of steam and hydroelectric plants.

TABLE 1 AN ESTIMATE OF THE UNIT INVESTMENT IN POWER PLANTS

	Water-power plants			Fuel-using plants		
Dec. 31 of year	Installed capacity, kw	Total cumulative investment	Average per kw	Installed capacity, kw	Total cumulative investment	Average per kw
1920	3,850,000	$ 962,500,000	$250	9,150,000	$1,148,500,000	$125
1921	4,025,000	1,015,000,000	252	9,635,000	1,199,000,000	124
1922	4,150,000	1,079,000,000	260	10,750,000	1,300,000,000	121
1923	4,600,000	1,153,000,000	250	11,900,000	1,509,000,000	127
1924	5,150,000	1,263,000,000	245	13,600,000	1,779,000,000	131
1925	5,850,000	1,369,000,000	234	15,100,000	1,954,000,000	129
1926	6,096,000	1,416,000,000	232	17,032,000	2,143,000,000	126
1927	6,554,000	1,485,000,000	227	18,794,000	2,299,000,000	122
1928	7,279,000	1,541,000,000	212	19,942,000	2,436,000,000	122
1929	7,439,000	1,593,000,000	214	22,120,000	2,623,000,000	119
1930	8,207,000	1,711,000,000	208	23,843,000	2,799,000,000	117

FUELS FOR STEAM-POWER GENERATION

A very considerable change is taking place, however, in the importance of the fuels used for electricity generation. Although there was a great gain in electrical output during the five years preceding 1930, the amount of coal used increased very slowly owing to the improved efficiency of production. There was a large decrease in the amount of coal used in 1930, and for 1931 the amount consumed as shown in Fig. 2, was less than for any previous year since 1924. The amount of fuel oil burned has likewise shown a marked decline during the past two years, having decreased 10 per cent in 1930 compared with the previous year, and 9 per cent more in 1931. The consumption of natural gas, on the other hand, has shown a

[1] First section of a paper entitled "Production and Transformation of Electrical Energy in the United States," by Alex. D. Bailey, A. G. Christie, F. A. Allner, and F. C. Hanker, prepared for but not presented at the International Electrical Congress, Paris, France, June, 1932. Other sections will appear in succeeding issues.

[2] Superintendent of Generating Stations, Commonwealth-Edison Company, Chicago, Ill. Mem. A.S.M.E.

steady increase for the last ten years, having gained 7 per cent in 1930 over 1929 and 11 per cent in 1931. Whereas coal constituted 85.5 per cent of the fuel used in 1929, based on heat equivalents, it formed less than 83 per cent of that burned in 1931. In addition, the improvements in operating efficiency with coal made further reductions possible, and although the output of electricity generated from fuels increased fifteen times

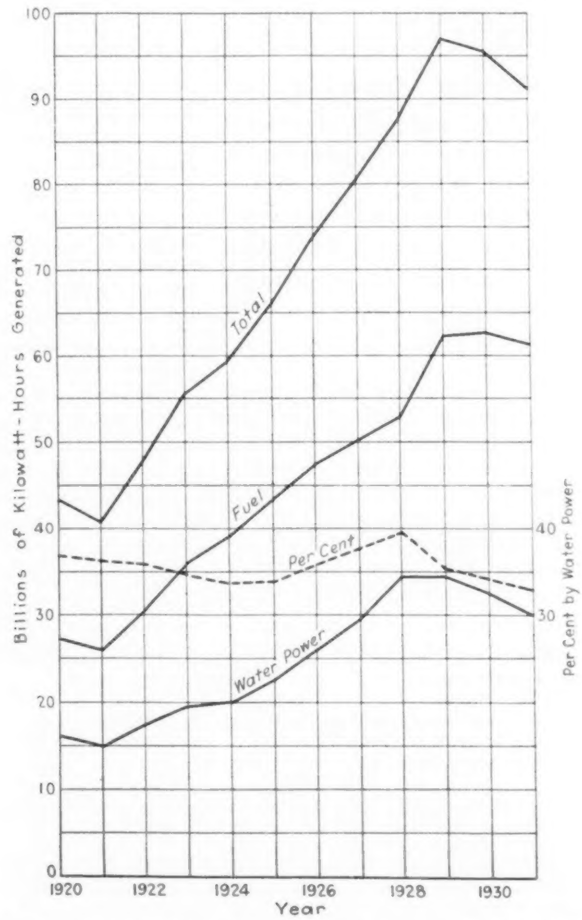


FIG. 1 KILOWATT-HOURS GENERATED BY FUELS AND BY WATER POWER, 1920–1931

from 1902 to 1930, the coal consumption increased only four times.

It is evident that the ratios between coal, oil, and gas will change from year to year owing to new discoveries of available fuels and to economic conditions. Comparatively recent discoveries of extensive supplies of natural gas in various parts of the country and the construction of large pipe lines have made this fuel a serious competitor of both oil and coal for steam stations. A significant fact is the use of natural gas from the Texas fields in one of the large stations of the Chicago district. This gas is transported a distance of a thousand miles by pipe line and passes the rich coal fields of Illinois less than two hundred miles away. Gas is supplanting fuel oil in certain steam stations on the Pacific Coast. The construction of new hydroelectric plants in California has practically stopped as a result of the low prices of both gas and oil, and because steam stations using these fuels can be built near the load at a much lower unit cost than hydro stations with their long transmission lines. Coal is plentiful, particularly in that part of the country where there is the greatest industrial activity. New supplies of natural gas are being discovered continually in various sections of the country. In addition, the overproduction of oil during the past year has banished from every one's mind, for the present at least, the idea prevalent only a few years ago that the available supply of this fuel was exceedingly limited.

It is evident that the cost of these resources at the source is not the all-important factor, but that transportation costs to the point of consumption, as compared with each other and with the cost of transporting energy electrically, will determine the trend in the use of various fuels and in their combined importance in the production of electricity. Another item to be considered is the "convenience factor," which in the case of oil or gas effects considerable savings in station investment and operating costs as compared with coal. This convenience factor, so-called for want of a better name, may even be an influence outside the station itself because of the recent interest of the public in air pollution due to smoke, dust, and fumes from the stacks of coal-burning industries. While it is evident that we shall be dependent primarily on fuels for the production of electrical energy, at least until present methods of production have been superseded, the choice of fuels and their relative importance will continue to be an interesting and absorbing study.

RECENT DEVELOPMENTS OF THE ELECTRICAL INDUSTRY

The outstanding features in the recent development of the electric-utility industry have been the centralization of power

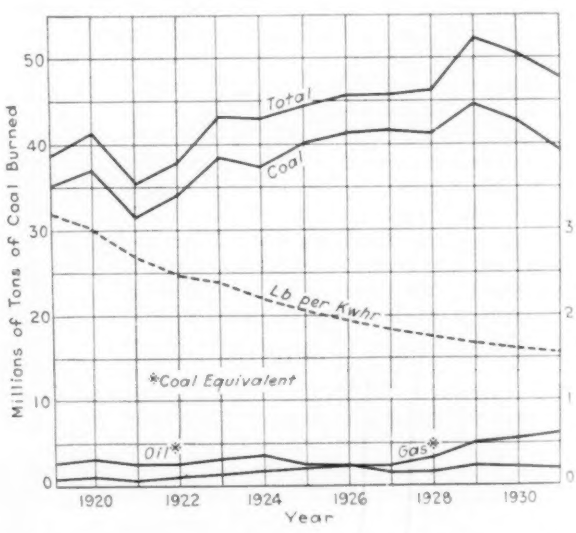


FIG. 2 CONSUMPTION OF FUEL BY ELECTRIC POWER PLANTS, 1920–1931

production, the interconnection of large systems, the extension of service into sparsely settled and rural communities, and the continued reductions in rates to users of the service. The first two features have resulted in decreased investment and operating costs without decreasing the reliability and quality of the service; and through interconnection the development of certain water-power sites has been made economically possible because of the steam reserve which has thus been made available.

Because of the high ratio of invested capital to income in the electricity-supply business, the amount of investment per unit of capacity must receive the greatest attention. At the present

time this ratio is 5.64 for the entire industry. This means that the annual income is less than one-fifth of the invested capital as compared with an income of several times the invested capital in certain other industries. A recent analysis, shown in Fig. 3, indicates that the average capital invested for the complete electrical system per kilowatt of generating capacity is steadily increasing. This increase results from the fact that the investment necessary for substations, transmission lines, and distribution systems has grown at the rate of 20 per cent in the last ten years. Meanwhile the unit cost of the power plant alone, which at present represents only 39 per cent of the total cost, has decreased 13 per cent during the same period.

Transmission costs have grown as a result of the centralization of power generation, and distribution costs have increased because of improvements in the service and because of the extension of the service into more scattered territory. While analysis and study of the industry explain these trends, serious consideration of growing total unit costs is nevertheless necessary. If the cost of large stations and their attendant transmission systems and substations is greater than the cost of smaller decentralized stations at the load, the difference in fixed charges must be more than offset by improved capacity factor and reduction in operating expense. Improvement in capacity factor reduces the fixed charges per unit generated, and also has a similar effect on operating cost. In addition, there is the reduction in operating cost due to larger and more efficient units. Because of these facts the system investment per kilowatt-hour sold has shown a gradual decrease.

Estimates of energy requirements must be forecast for several years so that plant equipment can be properly and economically planned and provided. Studies must be made of fuel and water resources available for power production. Contact must be maintained with all associated developments at home and abroad. Research must be instituted to determine not only improvements and refinements in plant construction and operation, but also to determine new uses for the product or the extension or improvement of present utilization. A great deal of this pioneering work has been done and must continue to be done by the electrical producers. The fact that the industry is non-competitive within itself and that the various organizations work together for the common good, is largely responsible for its growth both in size and usefulness.

The development of steam stations has reached such a point that there will be a continual decrease in the amount of the savings which can be realized by further improvements in the thermal cycle. The effect of load factor gains in importance. Much attention and study must be given to the operating problems of such systems, whether depending upon steam plants alone or with water power, in order to effect economical operation and to render satisfactory service. While the increment unit production costs are relatively small so far as final costs are concerned, the great output makes small gains become large amounts in the aggregate. Hence extended and detailed studies and surveillance are not only economically justified, but are expressly demanded if power is to be produced at lowest cost.

OPERATING CONSIDERATIONS

So far as operation is concerned, much has already been written, and operating procedure has been quite definitely established by each organization. Studies of steam-plant performance have been made for each installation and each generating unit so that the overall effect of load factor and capacity factor are accurately determined. Load variations, both daily and seasonal, are determined in advance from estimates of output, and load curves are prepared which guide the operating force in planning production. The most economical distribution of output can be arranged in advance for any given load, having in mind the service, operating cost, operating reserve, and all those other important items which are part of operating procedure. Station and even unit loads can be scheduled in advance so that the operators merely follow the loading schedule and adjust the output of their respective stations to suit load conditions at the time. In addition, with the output forecast and the resulting load curves laid out, it is possible to estimate operating efficiencies and costs in advance with considerable accuracy, to predict fuel requirements month by month, and to plan the loading of transmission systems.

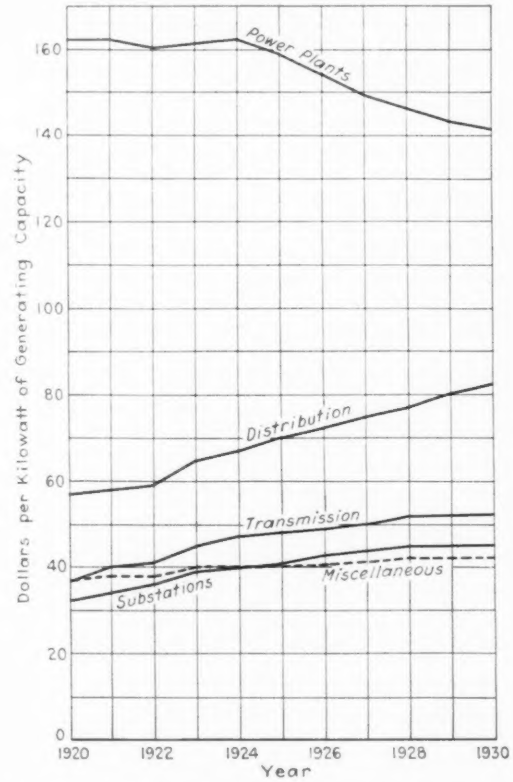


FIG. 3 TOTAL UNIT INVESTMENT PER KILOWATT OF GENERATING CAPACITY, 1920–1930

The operation of systems and of individual stations in emergencies occasioned either by failure of equipment or by sudden and unexpected load changes, for one reason or another, can be likewise planned in advance. Troubles which are anticipated can be eliminated or their effect very considerably reduced if proper instruments are installed so that each case of trouble can be readily located and identified. In an effort to reduce the personal element and to get better control, there has been a marked increase in the use of automatic equipment, a part of which serves the purpose of protection and a part, normal operation. While these devices have in a measure relieved the operators of a great deal of detail, and while there may be a tendency to emphasize and even overdo the matter of automatic operation, the importance and responsibility of the individual has probably been increased. Intelligent, highly trained men are now required for station operators.

The Basic Laws and Data of HEAT TRANSMISSION[1]

By W. J. King[2]

VI—EVAPORATION AND CONDENSATION

It is apparent, after a careful survey of the literature, that very little is known about these two heat-transfer processes, and that the available information is very poorly organized. Particularly in the case of evaporation, the data are so discordant and the theory so incomplete that general correlations are practically impossible. Many of the tests reported have been concerned only with the overall heat transmission, involving several processes in combination, so that the factors governing each component process cannot readily be isolated. It is clear that until these individual mechanisms are better understood and formulated, the application of the data will be more or less limited to those combinations for which actual test results are available. Accordingly, an attempt will be made here to define some of the basic problems involved, placing more emphasis on the fundamentals than on the various data for specific applications.

Nomenclature

The following symbols and units will be used throughout:

A = area, sq ft
D = diameter, inches
f = friction factor for fluid flow (dimensionless)
h = heat-transfer coefficient, $\dfrac{\text{Btu}}{(\text{hr})\,(\text{sq ft})\,(\text{deg F})}$
k = thermal conductivity, $\dfrac{\text{Btu}}{(\text{hr})\,(\text{sq ft})\,(\text{deg F/ft})}$
K = mass-transfer coefficient, $\dfrac{\text{lb}}{(\text{hr})\,(\text{sq ft})\,(\text{in. Hg})}$
L = length or height of surface, ft
M_V = molecular weight of vapor
M_m = mean molecular weight of vapor-gas mixture
P = total pressure, in. Hg
P_g = partial pressure of gas in mixture, in. Hg
P_L = vapor pressure of liquid at its free surface, in. Hg
P_V = partial pressure of vapor in mixture, in. Hg
P_{gf} = log mean partial pressure of non-condensing gas in film on free surface of liquid, in. Hg
q = rate of heat flow, Btu/hr
r = latent heat of vaporization, Btu/lb
t = temperature, deg F (subscripts a, V, s, and L refer to air, vapor, heating surface, and free surface of liquid, respectively)
T = temperature, deg F absolute or Rankine
v = velocity, ft/sec
w = rate of condensation or evaporation (mass transfer), lb/hr
Z = viscosity, centipoises
θ = temperature difference, deg F
ρ = density, lb/cu ft

The significances of the temperature and pressure terms are shown in Fig. 1, for the case of a vapor condensing from a mixture containing non-condensable gas. In the reverse process, evaporation, P_g and P_V would be interchanged and the temperature gradient would be in the opposite direction.

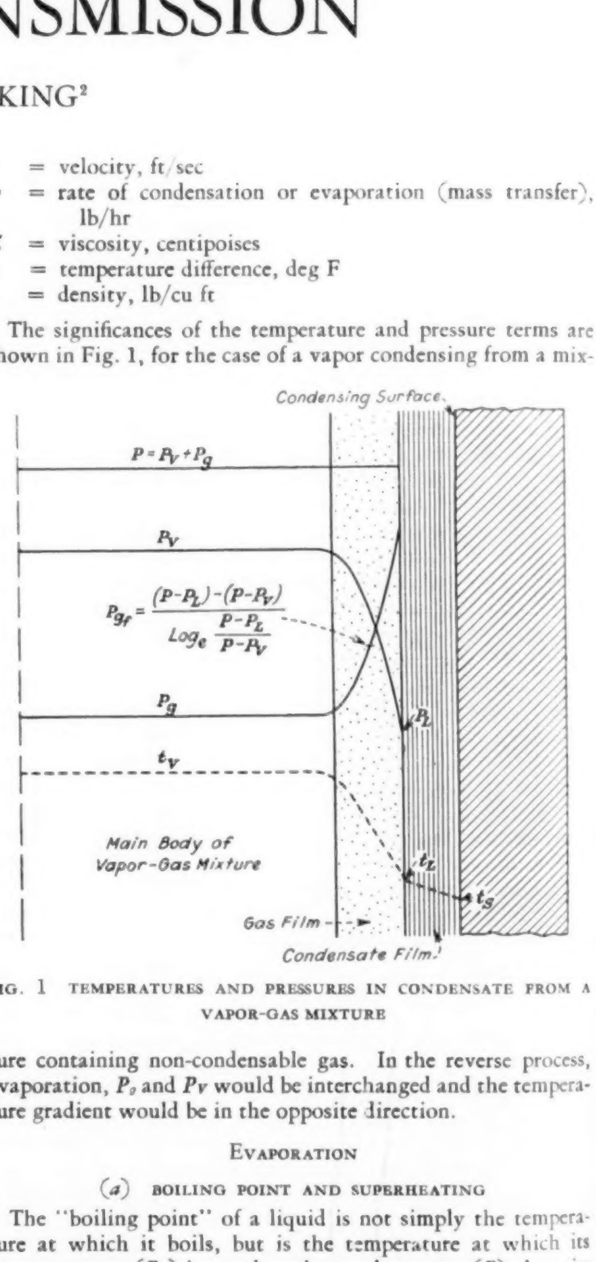


FIG. 1 TEMPERATURES AND PRESSURES IN CONDENSATE FROM A VAPOR-GAS MIXTURE

Evaporation

(a) Boiling point and superheating

The "boiling point" of a liquid is not simply the temperature at which it boils, but is the temperature at which its vapor pressure (P_L) is equal to the total pressure (P) above its free surface. However, the liquid may be heated until P_L is considerably greater than P without the occurrence of ebullition, or even when it is boiling vigorously the liquid may remain hotter than the vapor. This rise of the temperature above the boiling point is called the superheating of the liquid.

Superheating may be produced either by raising the temperature of, or lowering the pressure on, a liquid. In a test in the author's laboratory to demonstrate the extent to which a liquid may be superheated, a column of methyl formate at room temperature in a vertical glass tube supported a column of mercury 40 in. long, representing a negative pressure or tension

[1] Part I, a general survey of the subject, appeared in the March issue, pp. 190–194; Part II, on Conduction, in the April issue, pp. 275–279, 296; Part III, on Free Convection, in the May issue, pp. 347–353; Part IV, on Forced Convection, in the June issue, pp. 410–414, 426; and Part V, on Radiation, in the July issue, pp. 492–497.

The entire series of these articles on heat transmission is being reprinted in pamphlet formed and may be obtained for $1 per copy by addressing the Publications-Sales Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

[2] Engineering General Department, General Electric Company, Schenectady, N. Y.

of 10.2 in. Hg (5 lb/sq in.), without boiling. The superheating in a column of boiling water is shown in Fig. 2, according to the measurements of Jakob and Fritz.[3] Since the heating surface was at 225.7 F, the temperature of the water immediately in contact with it was 13.35 F above the boiling point. Many other tests are reported in the literature,[4] which show that a liquid may be superheated almost indefinitely under certain conditions.

The factors governing this phenomenon are not yet fully understood. The indications are that the tendency of a liquid to superheat is reduced by (1) the presence of dissolved gases or small particles which form nuclei for the formation of bubbles, (2) bubbling vapor through the liquid, (3) localized hot spots, such as heating by small filaments, and (4) raising the boiling point. The decrease in the slope of the pressure-temperature curve, or $\partial P_L/\partial t$, probably accounts in part for the increased tendency to superheat which has been observed when the boiling temperature is lowered.

(*b*) HEAT TRANSFER FROM HEATING SURFACE TO LIQUID

Superheating plays an important part in the evaporation process. As long as a liquid is heated or superheated without boiling, the heat transfer is governed by the ordinary laws of

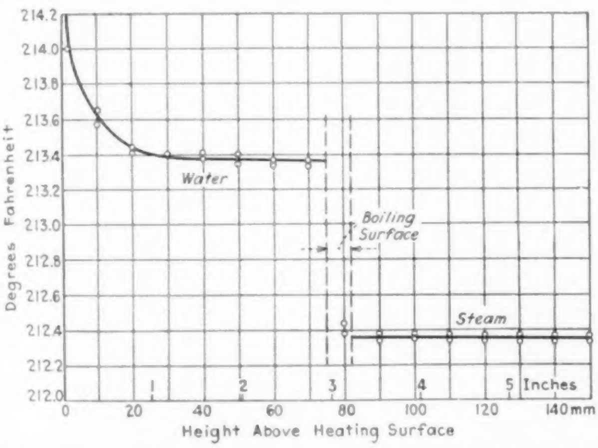


FIG. 2 TEMPERATURES IN WATER AND STEAM ABOVE A HORIZONTAL HEATING SURFACE

(From Jakob and Fritz. Heating-surface temperature, 225.7 F; heating rate, 5300 Btu per hr per sq ft.)

convection, and the coefficients are relatively low. It is to be expected that when a liquid boils the vapor bubbles will increase the circulation and the heat-transfer coefficient. But if the superheating in the liquid film is limited, so that the temperature of the surface in contact with it cannot rise beyond a few degrees above the boiling point, the coefficient will increase linearly with the heating rate. If the heating rate is low, or the liquid superheats readily, the first effect, circulation, may determine the heat-transfer coefficient, but if the heating rate is high, the coefficient may be governed entirely by the tendency of the liquid to superheat.

Figs. 3 and 4 show the results obtained by several investigators for the coefficient h, based on the metal-to-liquid temperature difference. Curves 1 and 2 are from the paper by Jakob and Fritz,[3] who have recently undertaken a study of the evaporation process. Curves 3, 4, and 5 are from Linden and Montillon's paper on heat transmission in an experimental inclined-tube evaporator.[5] Curves 6, 7, and 8 represent some unpublished results obtained by Dunn and Vincent at the Massachusetts Institute of Technology under the direction of Prof. T. B. Drew, to whom the author is indebted for permission to use them. The remaining curves, Nos. 9 to 12, were obtained by H. S. Young in the author's laboratory.

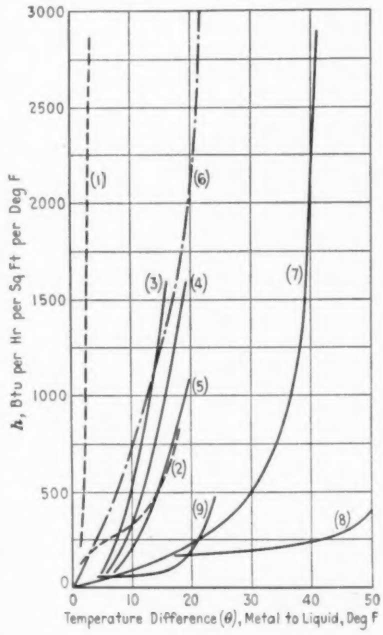


FIG. 3 COEFFICIENTS FOR EVAPORATING LIQUIDS

(1), (2)—Jakob and Fritz, water, 212 F, horizontal copper plate, (1) grooved, (2) polished chromium surface.

(3), (4), (5)—Linden and Montillon, water, (3) 210 F, (4) 195 F, (5) 180 F, inside inclined copper pipe, 1 in. × 4 ft.

(6), (7), (8)—Dunn and Vincent, (6) water, 212 F, (7) methyl alcohol, 149 F, (8) toluene, 232 F, horizontal copper plate.

(9)—Young, methyl formate and ethyl ether, 60 F, vertical copper plate.

A complete discussion of the results presented will not be attempted here, but from these and other tests on evaporating liquids the following observations may be noted:

1 The coefficient increases very rapidly with the temperature difference. The value of the exponent n in $h \propto \theta^n$ usually lies between 2 and 3.

2 At high heating rates, the coefficient increases almost linearly with the heating rate.

3 At very high

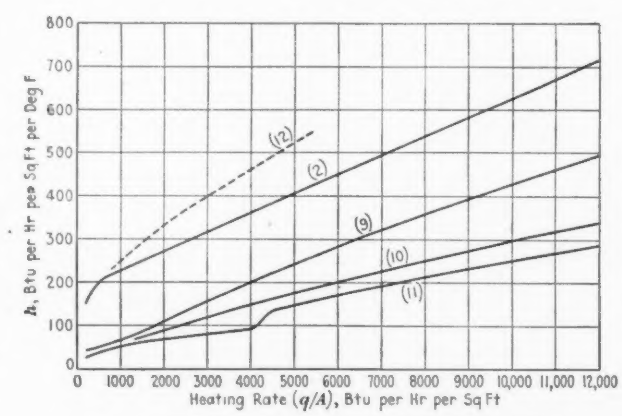


FIG. 4 COEFFICIENTS FOR EVAPORATING LIQUIDS

(2)—Jakob and Fritz, water, 212 F, horizontal copper plate, polished chromium surface.

(9)—Young, methyl formate and ethyl ether, 60 F, vertical copper plate.

(10)—Young, methylene chloride, 60 F, horizontal copper plate.

(11)—Young, CCl_4, 60 F, vertical copper plate.

(12)—Young, sulphur dioxide, 20 F, vertical copper cylinder.

[3] M. Jakob and W. Fritz, *Forschung*, vol. 2 (1931), p. 435.

[4] F. B. Kenrick, C. S. Gilbert, and K. L. Wismer, *Jl. Phys. Chem.*, vol. 28 (1924), p. 1297.
S. Lenher, *Jl. Phys. Chem.*, vol. 33 (1929), p. 1578.
A. Smits, *Jl. Phys. Chem.*, vol. 34 (1930), p. 1861.
C. Tomlinson, *Proc. Roy. Soc.*, vol. 17 (1869), p. 240; and *Phil. Mag.*, vol. 49 (1875), p. 432, and vol. 50 (1875), p. 85.

[5] C. M. Linden and G. H. Montillon, Trans. Am. Inst. Chem. Engrs., vol. 24 (1930), p. 120.

rates, a continuous film of vapor may form at the heating surface, separating it from the liquid and causing the surface temperature to rise sharply.

4 Ebullition may occur vigorously at certain points which are colder than adjacent points where no bubbles appear.

5 In several tests at moderately high heating rates it was found that the introduction of devices for promoting or retarding the circulation as much as possible had no effect upon the coefficient.

6 Circulation and ebullition may be very unstable, particularly at moderate heating rates.

7 Even with a heavy copper plate, uniformly heated, marked differences in metal temperatures may be found at various points on the surface.

8 Much more consistent results are obtained with perfectly clean surfaces.

9 The coefficient may gradually decrease with the duration of the heating time, apparently due to the removal of dissolved and adsorbed air. Jakob and Fritz found that the coefficient for water decreased by as much as 60 per cent after it had boiled for 12 hours, but increased again after the heating surface was allowed to stand a while in air.

10 Regular, periodic variations in temperatures and evaporating rates may occur.

This last effect was observed in a series of tests on sulphur dioxide boiling in a heavy copper cylinder. The copper was heated electrically by an external resistor winding, and the vapor was condensed in a coil of tubing submerged in a refrigerated-brine tank. Curve 12 of Fig. 4 represents the mean of about thirty widely scattered points obtained from these tests. After several attempts to secure steady operation, it was noticed that the mercury in the vapor-pressure manometer rose and fell in slow, regular cycles. With all controls at a fixed setting, a series of temperature readings were then obtained and plotted against time, with the results shown in Fig. 5. The heating rate was 9750 Btu/hr/sq ft, so that the apparent coefficient (h) at point A was 750 and at point B 177 Btu/hr/sq ft/F, and of course a variety of intermediate values were obtained when the copper temperature was measured at one time and the liquid at another. A similar "geyser action" has been reported by Stewart[6] for sulphur dioxide evaporating in copper tubes. Apparently it is due to the periodic superheating of the liquid in the film, up to the point where the vapor pressure overcomes the internal tension.

From the foregoing it should be evident that the heat transfer to an evaporating liquid is a rather uncertain process, and that more light will have to be thrown upon some of the effects mentioned before the coefficients can be predicted with confidence.

(c) HEAT TRANSFER ACROSS THE FREE SURFACE OF THE LIQUID

Appreciable temperature or pressure drops always occur across the free surface of an evaporating liquid. The total resistance to evaporation may be divided into two parts; the first is represented by the temperature drop in a thin layer of liquid just beneath the surface, and the second by the pressure drop from the surface to the vapor space. The first effect is purely thermal; the second is involved in the mass-transfer or vaporization process.

Very little can be said about the temperature gradient in the surface layer, except that the drop seems to vary from about 0.4 F to 2.0 F for boiling water up to 5.0 F for organic liquids. Bošnjaković[7] has studied this theoretically, but very few actual measurements have been made.

[6] F. E. Stewart, *Refrig. Engg.*, vol. 21 (1931), p. 21.

[7] F. Bosnjakovic, *Technische Mech. u. Thermo.*, vol. 1 (1930), p. 358.

Vaporization is primarily a mass-transfer process, since it is a function of the pressure difference rather than the temperature difference. The heat transfer is represented by the product of the mass transfer, from the liquid to the vapor state, times the latent heat of vaporization:

$$q = rw \quad [1]$$

Also, since

$$h = \frac{q}{A(t_L - t_V)} \text{ and } K = \frac{w}{A(P_L - P_V)} \quad [2]$$

the heat-transfer coefficient for a given condition may be calculated from the mass-transfer coefficient from the relation:

$$h = \frac{rK(P_L - P_V)}{t_L - t_V} \quad [3]$$

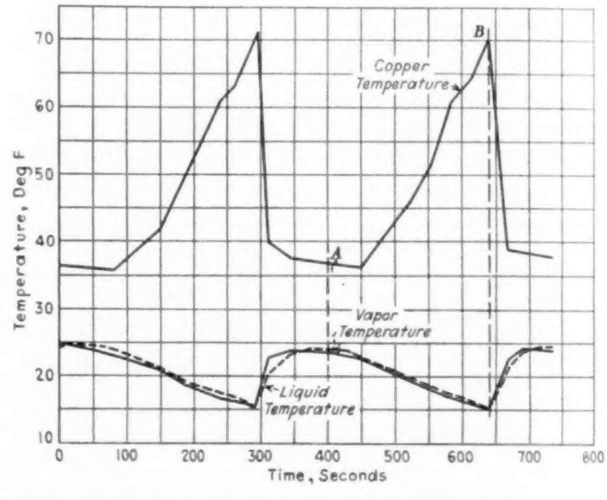


FIG. 5 TEMPERATURE CYCLES, SULPHUR DIOXIDE EVAPORATING IN COPPER CYLINDER

According to the kinetic theory, the value of K for a liquid evaporating into a space containing nothing but its own vapor (when $P_V = P$), can be calculated from its molecular weight and absolute temperature by means of the equation

$$K = 14{,}450\, a \sqrt{\frac{M}{T}} \quad [4]$$

where a is the "accommodation coefficient," or the fraction of the number of vapor molecules striking the liquid surface which condense. The value of a has not yet been determined definitely, but it is generally assumed that it is nearly unity.[8,9] The value of K for water at 212 F would then be 2370 lb per hr per sq ft per inch of mercury. At an evaporation rate of 3000 Btu or 3.1 lb per hr per sq ft of free surface, the pressure drop would be only 0.00131 in. of mercury.

Alty[10] has recently carried out some interesting experiments to determine the value of a for water and carbon tetrachloride. He plots a number of points for various pressures and extrapolates to $P_V = 0$, where he finds that a is unity for carbon tetrachloride but is only about one per cent for water. However, a seems to vary considerably at other pressures, and the results are not very convincing.

[8] A. P. Colburn and O. A. Hougen, Univ. of Wisconsin Eng. Exper. Sta., Bull. No. 70 (1930).

[9] S. C. Bradford, *Phil. Mag.*, 7th Series, vol. 10 (1930), p. 160.

[10] T. Alty, *Proc. Roy. Soc.*, Ser. A, vol. 131 (1931), p. 554; *Can. Jl. Res.*, vol. 4 (1931), p. 547.

From some tests on the evaporation of mercury, Knudsen[11] concludes that very small superficial impurities may diminish considerably the rate of evaporation from a surface, but it is possible to produce a liquid surface so pure that all vapor molecules striking it are able to traverse it and become part of the liquid.

In any event, it appears that the pressure or temperature drop from the surface of a boiling liquid to its pure vapor is generally so small as to be completely negligible. It is very probable, therefore, that the drop of one degree fahrenheit shown in Fig. 2 from the water to the steam occurred in the surface layers of the water.

When a liquid evaporates into an inert gas, such as air, the mass transfer takes place by diffusion, which is a relatively slow process. A few empirical formulas are available for the mass-transfer coefficient, K, for the diffusion of water vapor into air. The rate of evaporation is proportional to the coefficient, the area, and the difference between the vapor pressure of the water and the partial pressure of the water vapor in the main body of the air:

$$w = KA\,(P_L - P_V) \qquad [5]$$

Rohwer[12] has correlated a large number of data collected by the U. S. Department of Agriculture. Converted to the present units, his formulas are:

For still air,

$$K = 0.0173\,(t_L - t_a + 3)^{2/3} \qquad [6]$$

For moving air,

$$K = (1.465 - 0.0186P)\,(0.095 + 0.0174\,v) \qquad [7]$$

These are derived from tests in small tanks, with the water and air at ordinary atmospheric temperatures. For reservoirs, the coefficients were found to be about 23 per cent lower.

Royds[13] gives the following formula for still air, derived from Box's experiments with water at temperatures between 50 and 212 F:

$$K = 0.0313 + 0.000545\,t_L \qquad [8]$$

Thiesenhusen[14] measured the rate of evaporation from a pan of water at temperatures between 120 and 194 F to a current of air at velocities from 1.6 to 5 ft per sec, which he expresses in a form equivalent to

$$\frac{w}{A} = 3.3\,\sqrt{v}\,\log_e\left(\frac{P - P_V}{P - P_L}\right) \qquad [9]$$

For the range of conditions covered by the ordinary psychrometric chart for air-conditioning work, a simple relationship exists between the mass-transfer coefficient K and the coefficient h, for the transfer of *sensible* heat by convection between the air and the water surface:[15]

$$h = 12.2\,K \qquad [10]$$

For example, if a stream of air is blown over a wet-bulb thermometer, heat will be transferred to the wick by convection at the rate $q = hA(t_a - t_L)$ and water vapor will diffuse from the wick into the air at the rate $w = KA(P_L - P_V)$. At any air velocity, if the value of h is known, the corresponding value of K may be obtained from Equation [10].

[11] M. Knudsen, "Le Livre du Cinquantenaire de la Société Francaise de Physique," 1925, p. 144.

[12] C. Rohwer, U. S. Dept. Agric., Tech. Bull. No. 271 (1931).

[13] R. Royds, "Heat Transmission in Boilers, Condensers, and Evaporators," Constable & Co., London, 1921 (N. Y., IN-CE-CO Pub. Corp.).

[14] H. Thiesenhusen, *Gesundheits-Ingenieur*, vol. 53 (1930), p. 113.

[15] See D. K. Dean, *Power*, vol. 62 (1925), p. 754.

Additional information on evaporation will be found in the references indicated.[16]

CONDENSATION

In many respects condensation is simply the reverse of the evaporation process, except that there is no ebullition and the heat usually flows through a thin film of liquid on the cooling surface. For a pure vapor, practically the entire resistance to the heat flow is represented by the temperature drop across the condensate film, whereas if considerable amounts of non-condensable gases are present, the slow diffusion of the vapor through the gas is the limiting factor, and the temperature drop in the liquid is relatively small. (See Fig. 1.)

(a) PURE VAPORS

Monrad and Badger[17] have presented an excellent paper on the condensation of vapors, in which they have given a review of the major contributions to this subject, including the work of Nusselt.[18]

Nusselt's theory for pure saturated vapors, which agrees very well with most of the experimental data, is based on the assumption that the heat flows by pure conduction through a film of condensate moving in streamline flow. The entire temperature drop from the vapor to the cooling surface occurs across this film. The following formulas were derived for the heat-transfer coefficient in terms of the size of the surface, the temperature drop, and the properties of the liquid at the mean film temperature:

For a vertical surface of high L feet,

$$h = 105\,\sqrt[4]{\frac{r\rho^2 k^3}{ZL\theta}} \qquad [11]$$

For a horizontal pipe of diameter D inches,

$$h = 152\,\sqrt[4]{\frac{r\rho^2 k^3}{ZD\theta}} \qquad [12]$$

(For a bundle of pipes, D is the sum of the diameters in a vertical row.) Convenient charts for these and other heat-transfer formulas have been presented recently by Chilton, Colburn, Genereaux, and Vernon.[19]

Unlike most other heat-transfer processes, the coefficient for condensing vapors decreases as the temperature drop increases, due to the building up of the condensate film. However, as Monrad and Badger point out, at high vapor velocities or for tall vertical surfaces turbulence may develop in the film, with the result that the coefficient is higher than would be indicated by formula [11].

The presence of even small amounts of non-condensing gas, such as air, in a vapor may have a marked effect in reducing the heat-transfer coefficient. The effects of various percentages

[16] (a) E. Hausbrand and M. Hirsch, "Verdampfen Kondensieren und Kühlen," J. Springer, Berlin, 1931.
(b) A. L. Webre and C. S. Robinson, "Evaporation," Chem. Cat. Co., N. Y., 1926.
(c) W. L. Badger and W. L. McCabe, "Elements of Chemical Engineering," McGraw-Hill, N. Y., 1931.
(d) F. Merkel, "Verdunstungskühlung," V.D.I. Forschungsheft 275 (1925).
(e) W. H. Walker, W. K. Lewis, and W. H. McAdams, "Principles of Chemical Engineering," McGraw-Hill, N. Y., 1927.

[17] C. C. Monrad and W. L. Badger, Trans. Am. Inst. Chem. Engrs., vol. 24 (1930), p. 84.

[18] W. Nusselt, *Zeit. V.D.I.*, vol. 60 (1916), p. 541.

[19] T. H. Chilton, A. P. Colburn, R. P. Genereaux, and H. C. Vernon, "Heat-Transfer Design Data and Alignment Charts." Paper presented at the National Process Meeting, A.S.M.E. (Pet. Div.), Buffalo, June, 1932.

of air in steam are shown by the curves of Fig. 6, from a paper by Othmer.[20] The percentages are by volume, so that

$$\text{Per cent air} = 100\,\frac{P_g}{P} = 100\,\frac{P - P_V}{P} \quad\ldots\ldots\ldots\ldots [13]$$

Very few data for other condensing vapors are available. McAdams and Frost[21] obtained coefficients of about 300 for carbon tetrachloride and 350 for benzene. Some rather scattered data reported by Monrad and Badger indicate an average value of $h = 300$ for condensing diphenyl vapor. An elaborate series

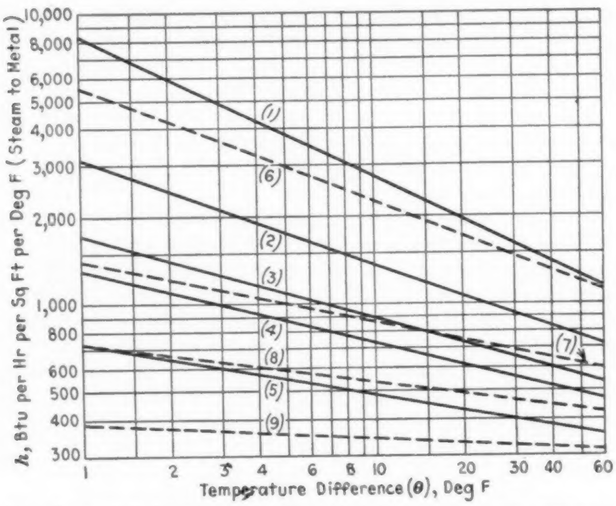


FIG. 6 COEFFICIENTS FOR STEAM CONDENSING ON A HORIZONTAL 3-IN. TUBE

[From Othmer, *Ind. Eng. Chem.*, vol. 21 (1929), p. 576.]

Solid Lines (t_V = 230 F):	Broken Lines (t_V = 212 F):
(1) = 0 per cent air	(6) = 0 per cent air
(2) = 1.07 per cent air	(7) = 1.42 per cent air
(3) = 1.96 per cent air	(8) = 3.47 per cent air
(4) = 2.89 per cent air	(9) = 6.21 per cent air
(5) = 4.53 per cent air	

of tests on heat transfer in ammonia condensers are described in three bulletins issued by the University of Illinois.[22] Only the overall heat transfer from ammonia to water flowing in pipes was measured directly, but an approximate value of 1635 was obtained graphically for the ammonia-film coefficient.

A number of investigators, including Nusselt,[18] Jakob and Erk,[23] Bošnjaković,[24] and Kirschbaum[25] have studied the condensation of superheated steam. Their results may be summarized by the statement that, in general, the same amount of heat is transmitted by condensing superheated steam as by saturated steam at the same pressure. In other words, the heat-transfer coefficients are about equal if the temperature of the steam is taken as the saturation temperature. If the temperature of the surface is above the saturation point, the heat will be transferred by convection only.

(*b*) VAPOR-AIR MIXTURES

Although the heat transfer from condensing impure vapors may be calculated from empirical data of the type given by Othmer, the method used by Colburn and Hougen[26] and by Langen[27] is more general and should be applicable to a greater variety of conditions. This method consists in computing the coefficient for the mass transfer of the vapor from the main body of the mixture to the free surface of the condensate, and the heat-transfer coefficient across the condensate film. The heat-transfer rate is then:

$$q/A = h\,(t_L - t_s) = Kr\,(P_V - P_L) \quad\ldots\ldots\ldots [14]$$

The value of t_L is generally unknown. It may be obtained by trial and error, or by plotting Equation [14] against t_L. Since P_L is a function of t_L, the intersection of the curves for q/A obtained from the two expressions in [14] will give the required value of t_L. (See Fig. 7.)

The value of h may be obtained from formula [11] or [12]. It will be noted that h is a function of θ, which is equal to $t_L - t_s$. Since θ enters these formulas only to the one-fourth power, its value may be estimated roughly in the initial computations of h without entailing appreciable error.

Colburn and Hougen have given a number of data and formulas for K, derived from tests on condensing-water vapor-air mixtures flowing through the annular space between two pipes. In a recent private communication, Dr. Colburn recommends a general equation for this type of problem, which becomes in the present units

$$K = \frac{3600\,(f/2)\,M_V \rho v}{P_{af} M_M} \quad\ldots\ldots\ldots\ldots [15]$$

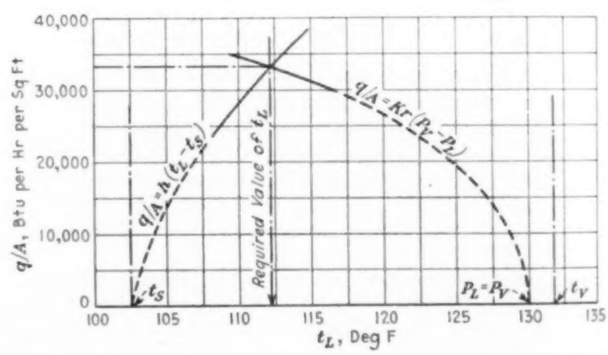


FIG. 7 METHOD FOR OBTAINING VALUE OF t_L IN EQUATION [14]

He advises that the data in the University of Wisconsin bulletin[26] may be correlated by the formula

$$K = \frac{29\,M_V\,(\rho v)^{0.8}}{P_{af} M_M D^{0.2}} \quad\ldots\ldots\ldots\ldots [16]$$

for forced convection, and by

$$K = \frac{0.65\,M_V (P_V - P_L)^{1/3} P^{1/3}}{M_M P_{af}} \quad\ldots\ldots\ldots\ldots [17]$$

for free convection or very low velocities.

Hirsch[16(a)] gives a formula for steam-air mixtures based on Langen's data for low velocities, which may be reduced to the form

$$K = 0.115 \left(\frac{P_V}{P_g}\right)^{2/3} \quad\ldots\ldots\ldots\ldots [18]$$

Langen finds that the mass-transfer rate is proportional to the square root of the pressure difference, but this conclusion

[20] D. F. Othmer, *Ind. Eng. Chem.*, vol. 21 (1929), p. 576.
[21] W. H. McAdams and T. H. Frost, *Ind. Eng. Chem.*, vol. 14 (1924), p. 13.
[22] A. P. Kratz, H. J. Macintire, and R. E. Gould, Univ. of Ill. Eng. Exper. Sta., Bull. No. 171 (1927), 186 (1928), and 209 (1930).
[23] M. Jakob and S. Erk, *V.D.I. Forschungsheft*, 310; also *Zeit. V.D.I.*, vol. 73 (1929), p. 761.
[24] F. Bosnjakovic, *Forschung*, vol. 3, no. 3, 1932, p. 135.
[25] E. Kirschbaum, *Archiv. für Waermewirtschaft*, vol. 12 (1931), p. 265.
[26] A. P. Colburn and O. A. Hougen, Univ. of Wisconsin Eng. Exper. Sta., Bull. No. 70 (1930); also *Ind. Eng. Chem.*, vol. 22 (1930), p. 522.
[27] E. Langen, *Forschung*, vol. 2 (1931), p. 359.

is not supported by a complete theory and may be due to the fact that the data were not correlated in terms of the proper variables.

Conclusion

The present series of articles comprise a very brief summary of the theory and data of heat transmission. There is obviously a need for a more complete work on this subject in the English language. In recognition of this need, the National Research Council's Committee on Heat Transmission several years ago adopted a program which included the publication of two comprehensive texts, one on the promotion of heat transfer, and the other on heat insulation. It was arranged to have these books written by the leading authorities in these fields, with the cooperation of the entire Committee. The text on promotion of heat transfer, which is being prepared by Prof. W. H. McAdams, of the Massachusetts Institute of Technology, is now nearly completed, and will probably be published before the end of the year. The work on insulation is being compiled by Edgar C. Rack, of the Johns-Manville Corporation.

It is to be expected that these two volumes will be of especial significance, in providing the most complete and authoritative information in their respective fields, and in establishing the theory and practice of heat transmission upon a sounder basis.

A.S.C.E. Asks for Data on Dams

The Committee on Dams of the American Society of Civil Engineers is making a study of hydrostatic pressure both within and under the bases of dams. In this connection the committee invites the cooperation of engineers in every country who are designing or constructing dams.

The committee desires facts as noted by careful observation, and not opinions or theoretical discussions. Present knowledge regarding actual uplift under and within dams is limited. Therefore, we ask engineers, when designing a dam, to incorporate in their plans methods of observing the hydrostatic pressures which will develop when the structure goes into service. All useful information that comes to the committee will be published for the benefit of the profession and full credit will be given to those who furnish reliable data.

Each engineer may design a method to measure uplift to suit his local conditions. The simplest installation for observing uplift is a system of pipes in which the pressure at the lower end may be measured by gage or in a riser pipe. All pipes should be built into the dam as it is being constructed, with their lower ends open. For measuring hydrostatic uplift under the base, the pipes should terminate in suitably arranged cavities, filled with granular material, at the base of the structure. The pipes should be spaced at intervals along the length of the dam, and at each location there should be not less than three pipes in an up and down stream direction, this number increasing with the width of the base. If a rock foundation has extensive or nearly horizontal stratifications, other pipes should be carried down below the base to some of the rock joints. The locations and elevations below the base should be governed by the character of the foundation material, whether rock or soil, and the purpose should be to locate the pipes systematically in both longitudinal and transverse directions with the view to developing all possible conditions.

For measuring hydrostatic uplift within the structure, similar pipes should be arranged with their open lower ends at different elevations above the base, as the design of the structure will permit. It would be well to have their lower ends open into horizontal construction joints.

The pipes may be led to one or more central observing points as found convenient, so long as the grade is always upward. The size of the pipes is not important, but should be such as to permit observations of the water levels within them.

The cost of installing such pipes will be small when a dam is under construction, while the benefits to be derived may be very great. The public has a direct interest in the safety of dams.

It is requested that the following procedure be carried out:

1 Observe the water level or water pressure in each pipe at intervals which should be practically simultaneous for each cross-section, recording also the levels of the reservoir and tail-water surfaces. The observation intervals should be frequent as the reservoir is filling. Thereafter every week or every month will suffice. At least a year's observations should be recorded.

2 Observe the temperature of the water, both in the reservoir and in the pipes. There is some evidence that uplift pressure may be affected by temperature.

3 Send in the observations at intervals. Also drawings of the dam showing the pipe locations, and necessary cross-sections, all to scale. The drawings should illustrate the details of the cut-off and the drainage system, if any, and show all other pertinent data. Also describe the character of concrete or masonry, and methods employed to secure bonding and to obstruct flow of water through the structure.

4 Send a detailed description of the foundation material, presenting all of its known characteristics, together with geological sections, both longitudinal and transverse, showing joint systems, faults, bedding, etc. Photographs of the foundations also will be useful.

5 Repeat the observations asked for in paragraphs 1 and 2 sufficiently often so that seasonal variations will be disclosed. These repeated observations should be sent when made. Do not hold back the data asked for in 1, 2, 3, and 4, as its receipt may suggest the securing of other information that may be highly important.

6 Send all communications to H. de B. Parsons, 26 Beaver Street, New York, N. Y., U. S. A., who will acknowledge for the committee.

The committee would be glad to correspond regarding details should any one so desire.

Product Design for the Market

(Continued from page 546)

of a type of engineer who can visualize and correlate problems of both consumption and production. We have all too few such men. The answer is simple. Train your designers in production methods, but make them understand that methods and processes are their servants, not their masters. Keep them in touch, as directly as possible, with your ultimate customers. Let them realize the importance of the product in the selling scheme. Then revamp your organization so as to bridge the gap between the requirements of the market and those of the factory. In no other direction do there exist better possibilities for reducing selling costs and increasing profits.

MECHANICAL ENGINEERING

Vol. 54 AUGUST, 1932 No. 8

GEORGE A. STETSON, *Editor*

George K. Burgess

NOT so long ago we noted in these columns the passing of Samuel W. Stratton, President of M.I.T., and first director of the United States Bureau of Standards. His end came while his work was in full progress. His successor as director of the bureau, George K. Burgess, was also stricken while at work on July 2 and died within a few hours.

Dr. Burgess was known among scientists and engineers for his researches in the measurement of high temperatures and in metallurgy. Among the many activities that the Bureau of Standards has undertaken in the interests of engineers, readers of MECHANICAL ENGINEERING will recall the recently constructed hydraulic laboratory described in the April and May issues, and the work in the thermal properties of steam that scientists at the bureau have reported in these pages over a period of many years. In common with all Government activities, those of the Bureau of Standards were seriously curtailed by the recent economy measures forced upon the Administration by business conditions. The threat of these economies to the effectiveness of the organization that Dr. Burgess, and Dr. Stratton before him, had built up had, no doubt, thrown an unusual and exhausting load upon the energies of the director. Engineers everywhere mourn the death of Dr. Burgess, but are grateful for the services he rendered their profession as an individual and as Director of the Bureau of Standards.

Concluding an Outstanding Series

WE cannot pass over the opportunity afforded by the appearance of the concluding article of W. J. King's series on heat transmission without uttering a word of grateful acknowledgment to the author for the service he has rendered his fellow engineers in the preparation of this valuable review of a field of technology that is of large and growing importance. Those who have followed Mr. King's articles must have been impressed with the great wealth of material represented by them. A rich bibliography affords access to original sources, but the coordination of the available data so skilfully interpreted and codified puts into the hands of every one a mass of material that nothing but months of painstaking search of the literature and the digesting of innumerable results would have made possible otherwise. Mr. King has performed a task of the first magnitude for the benefit of his brother engineers. All engineers who work in this field are now in his debt. Only by making their own special knowledge available to others, as Mr. King has done, can those who profit from his studies discharge the debt thus laid upon him. Engineering societies exist for the purpose of giving wide publicity to such additions to knowledge as Mr. King has offered in his articles. The spirit of the founders of The American Society of Mechanical Engineers bears rich fruit in contributions such as Mr. King has made.

Unemployment of Engineers

IN our March, 1932, issue we called attention to the report of the Professional Engineers' Committee on Unemployment published in *Civil Engineering*. This same journal published in its June issue a further statement of the work carried on by this committee in the New York district. We commend it to the attention of all engineers interested in this trying problem.

Up to May 14 (its work began last October) the committee had registered 2163 men and had placed 1389. Of these 307 were on the P.E.C.U. payrolls, 879 had received relief from other cooperating agencies, and 203 had been placed in permanent engineering jobs. Members and non-members alike of the four Founder Societies were registered and aided; 61.7 per cent of those registered were non-members, 45 per cent of whom were placed. Three hundred and forty-five members of the A.S.M.E. were registered (15.9 per cent of the total), and 248 were placed.

The finance committee raised $107,841 in cash and pledges from 3286 individuals. Ninety per cent of this money came from members of the four Founder Societies. Figures for the A.S.M.E. show a total of 1056 contributors, or 32.2 per cent of the entire number, and contributions of $20,355, or 18.9 per cent of the total contributions in dollars. The average contribution per member contributor was $19.20, which compares with $49.20 per contributor for the A.I.M.E., $47.40 for the A.S.C.E., and $24.20 for the A.I.E.E.

After mature consideration of all factors involved the committee decided to cease registration on April 9. A nucleus of the committee's staff is being held over until October 1. Non-members went off the committee payrolls on April 15; married non-members and unmarried members May 1, and married members May 15. A reserve of money to recommence activities on October 1 has been set aside and the remainder of the funds are being held to take care of married destitute members in Class A from May 15 to October 1.

The problem facing the committee is a serious one. There are prospects of a greater need for money and jobs as the summer wears on and another winter is faced. The committee feels that it must keep itself in financial condition to assist members who have been forced by circumstances beyond their control into positions of destitution. Every one should help in this worthy enterprise. Jobs and money are urgently needed.

Civil Engineering for July publishes a report of the engineers' and architects' relief program in Boston, under the

direction of the Emergency Planning and Research Bureau, Inc., which was organized early in 1931 to carry on unemployment relief. Up to June 16, 1932, the report states, a total of 865 engineers and 212 architects had been registered, of whom 198 engineers and 121 architects had been placed. Funds amounting to $62,024 had been raised up to this same date.

Thirteen professional-society groups are cooperating in the Boston relief work. Non-members represent 71.8 per cent of the total registered and 75.8 per cent of the total placed. From the Boston Section of the A.S.M.E., 62 were registered and 5 placed. The greatest number of applicants were in the age group from 26 to 30. Out of a group of 638 registrants, 503 were 40 years old or younger and 29 per cent were graduates of engineering schools.

An Engineer's Economic Conference

WE have frequently commented in these columns on the intense interest engineers are showing at the present time in problems involving economics. Although a technical engineering periodical, Mechanical Engineering has, during the past few years, devoted much space to the writings of engineers and economists on the problems which particularly affect our economic and social environment. These many displays of interest in economics on the part of engineers are significant and encouraging.

An enthusiastic leader in this movement has been Dr. Harvey N. Davis, president of Stevens Institute of Technology, under whose leadership an economic conference for engineers was held at the Stevens Engineering Camp during the latter part of last summer. A brief comment on the purposes and results obtained at this camp was made in Mechanical Engineering for October, 1931. It has recently been announced that a second conference will be held this year from August 27 through September 5, the general theme being money and banking. While last year Columbia and Stevens sponsored the camp, this year's announcement has been made on behalf of alumni and engineering associations of Brown University, Columbia, Cornell, Harvard, Massachusetts Institute of Technology, Princeton, Rensselaer Polytechnic Institute, Stevens Institute of Technology, Yale, and the American Association for Adult Education.

The scheme of this year's program involves discussions from eight to twelve daily, except Sundays, on money and banking. The discussions on money will be led by W. D. Ennis; those on banking by A. Dere Shaw. Afternoons will be given over to recreation, and at the evening sessions, at which President Davis will preside, there will be lectures by eminent authorities. Judging from last year's experiences, the spirit of the lectures and of the discussions which follow them will be informal. All those who had the privilege of attending last year's conference bear witness to the mental exhilaration experienced as a result of the two or three hours given over every evening to this part of the program. An opportunity is offered here for recreation for both mind and body amid delightful natural surroundings and in the atmosphere of good fellowship provided by intelligent and interested engineers.

Development of the Engineer

APPROVAL by five of the seven bodies represented at a conference held in New York, April 14, 1932, on certification into the engineering profession, of a proposal to establish the Engineers' Council for Professional Development assures the immediate formation of that Council. To date the A.S.C.E., the A.I.E.E., the S.P.E.E., the A.S.M.E., and the American Institute of Chemical Engineers have approved the proposal and named representatives on the council. Action is still to be taken by the other two bodies who participated in the framing of the plan, the A.I.M.E. and the National Council of State Boards of Engineering Examiners.

The plan for joint action proposed by the Conference for Certification into the Profession and approved by the bodies named above has as its general objective "the enhancement of the professional status of the engineer. To this end, it aims to coordinate and promote efforts and aspirations directed toward higher professional standards of education and practice, greater solidarity of the profession, and greater effectiveness in dealing with technical, social, and economic problems."

An immediate objective is stated as being: "the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself, through the development of technical and other qualifications which will enable him to meet minimum professional standards."

Joint action is recognized as an essential element in the attainment of these objectives, and a joint agency to be known as the "Engineer's Council for Professional Development" is to be organized to carry them out. It will be the function of this Council to recommend to the governing boards of the several cooperating organizations procedures for promoting the general objectives, and to administer such procedures as shall be approved by these boards.

The initial program proposed is as follows:

"First, to develop further means for the educational and vocational orientation of young men with respect to the responsibilities and opportunities of engineers, in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members;

"Second, to formulate criteria for colleges of engineering, which will insure to their graduates a sound educational background for practicing the engineering profession;

"Third, to develop a program for the further personal and professional development of young engineering graduates and a program for those without formal scholastic training;

"Fourth, to develop methods whereby those engineers who have met suitable standards may receive corresponding professional recognition."

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

CORROSION

The Bonderizing Process

THIS is a process by which a steel surface can be converted into insoluble basic phosphates in 7 to 10 min. It is based on substantially the same ideas as the Parkerizing process. It has been found, however, that steel surfaces which have been cold rolled, and therefore superficially hardened by cold work, are slow and difficult to attack by the Parkerizing process.

On the other hand, Parkerizing has a rustproofing value which Bonderizing does not claim. The latter is considered as an economical primer, as a base for paint, lacquer, or enamel, but it does not lend itself in any way to any of the Parkerizing oil finishes. Two powders are used in this process: one called Parco powder, and the other (a small amount), Bonderite powder. The compositions are not given. The Bonderizing process is carried on in a nearly boiling liquid for 7 to 10 min, this being followed by rinsing in clean hot water and drying in a heated oven. The reaction which produces the result is not explained. (A. R. Page in *The Metal Industry*, vol. 40, no. 14, April 1, 1932, pp. 369–371, *g*)

ENGINEERING MATERIALS (See Metallurgy: Iron-Boron Alloys and 18-8 Steels With Boron)

FUELS AND FIRING

Pipe-Line Transportation of Pulverized Coal

TRANSPORTATION of pulverized coal for great distances in pipe lines is done in Germany exclusively by pneumatic methods. Before the introduction of pulverized-coal firing in that country, this method of transportation had been applied to bulk materials, grain, ashes, and the like. Pneumatic conveying can be done either by suction or by compressed air.

In general, suction operation is preferable, but it can be used only for distances up to 450 yd. Pressure must be employed for greater distances, but this can be used only up to 2000 yd. For still greater distances, intermediate stations must be installed. In many cases suction and pressure operation are combined.

Large pipe cross-sections must be used, as a large amount of air is necessary for transportation. Depending on the length of pipe, the air consumption is from 4200 to 10,000 cu ft per long ton of pulverized coal, or 1.5 to 6 per cent of the air required for combustion.

Naturally, the intimate mixture of air and dust increases the danger of explosion in the transporting installation, especially with high-volatile and easily ignited coals such as brown coal; consequently transporting installations for brown coal use an inert gas such as flue gas. In this case a circulating system is adopted so that the gas may be used over and over again. Because of the danger of explosion when using air for transporting easily ignited dust, the pipe lines should not be placed in the vicinity of open flames or objects that radiate heat strongly, such as furnaces, ovens, or boilers. They also must be grounded, and electric wires should not be hung from them.

The return pipe circuits mentioned above have the advantage that the gas or air can be heated from condensing on the inside walls of the pipe lines. It is recognized that condensation of water in pipe lines causes adherence of the dust, and therefore rapid clogging and considerable trouble. In addition, the power consumption is higher with moist dust than with dry dust. In a plant built for a capacity of 10 to 15 long tons of pulverized coal per hour, a moisture content of 5 per cent in the dust reduced the actual conveying capacity to only 5 to 6 long tons per hour. In addition to the requirements for minimum moisture content, a certain fineness of the dust must be removed. Ordinarily a dust with a residue of 1 per cent on a sieve with 76 meshes to the inch is required.

It is important that the lines be straight, with as few bends as possible, and that the gradient be as uniform as possible without abrupt transitions. In rebuilding one installation the number of bends was reduced from 14 to 3, resulting in a power saving of 30 per cent.

With the high velocities (65 to 130 ft per sec) generally used, there is considerable wear in the pipe lines. In one plant that operated 24 hours a day, the bends had to be renewed after two years; consequently it is advisable to make the bends with rather large radii so that the power consumption and wear will not be too great. In addition they should be made so that they can be replaced easily, or with removable sections. Frequently the outside of the bend is provided with a cement back. In an installation operating under normal load-conveying conditions, using a pipe diameter of 8 in. and an air velocity of 65 ft per sec, it was necessary to make a replacement after conveying 130,000 long tons.

The installation cost for a pulverized-coal conveying system having a capacity of 15 long tons per hour and a length of 270 yd, including blower but without motor, is, in Germany, about $340 to $430 per ton. (Fredrich Schulte in a paper before the Third International Conference on Bituminous Coal, 1931, Pittsburgh, Pa.; abstracted through *Power Plant Engineering*, vol. 36, no. 6, Mar. 15, 1932, p. 252, *g*)

Gasoline Viscosity

VERY little is known and practically nothing has been published in regard to viscosity of gasoline, although this information is essential in the design of pipe lines to carry this substance. The Phillips Petroleum Company in the recent construction of its gasoline line used a modification of Williams and Hazen's formula. The company is keeping a careful record of daily operation of the line, and hopes that by cooperation much can be learned regarding friction losses in gasoline lines. One of the points upon which considerable difference of opinion exists is the factor which should be used for roughness of pipe.

There are two schools of thought among pipe-line engineers concerning the design of gasoline lines. One group adheres to the idea that gasoline lines differ so fundamentally from oil lines that the use of oil-pipe-line formulas is impractical. The other group, of which Mr. Heltzel is a member,

adheres to the belief that formulas long used by oil-pipe-line engineers are adaptable with special modifications. (Stanley Learned, Engr. for Phillips Petroleum Co., in a paper before the Mid-Continent Section of The American Society of Mechanical Engineers, Tulsa, Okla., Mar. 10, 1932. Abstracted through *The Oil Weekly*, vol. 65, no. 1, Mar. 18, 1932, p. 18, *g*. W. G. Heltzel referred to in the abstract is chief engineer for Stanolind Pipe Line Co. and chairman of the Petroleum Division of the A.S.M.E.)

INTERNAL-COMBUSTION ENGINEERING (See also Motor-Car Engineering: A Diesel-Engined Automobile; Pumps: Operation Costs of Diesel-Driven Centrifugal Units)

Italian Diesel-Locomotive Practice

A PAPER dealing with this subject was read in February, 1932, before the Institution of Locomotive Engineers (British) by F. A. Pudney, who described three types of Diesel-engined locomotives. The Diesel-compressed-steam locomotive on the Cristiani system consists essentially of a Diesel engine directly coupled to a three-stage compressor which deals with steam previously raised to a low pressure in a small generator by means of normal oil-fuel burners. The low-pressure steam is compressed and in effect passed to a high-pressure storage tank, from which the supply is fed through the usual locomotive cab-control regulator to the locomotive cylinders. The exhaust steam is in turn discharged to the low-pressure storage system, thus resulting in a closed-circuit operation. The system is interesting and ingenious, and has several advantages, not the least of which is the use of normal steam-locomotive controls. We are of the opinion, however, that the complication is hardly worth the advantages obtained or claimed. Only one experimental machine of this type has been built. The second type was a straight Tosi Diesel-electric locomotive with a standard Tosi engine driving twin direct-current generators through speed-increasing gearing. It is a fairly old design using a comparatively slow-speed heavy engine. The third locomotive was an Ansaldo direct drive. In this scheme the engine scavenge pumps are mounted on the locomotive frame in the position usually occupied by the outside cylinders in a steam locomotive. These pumps are provided with crossheads, and are driven from the engine crank by means of connecting rods. The engine carries a battery of high-pressure air receivers, and for starting, air is introduced into the scavenge-pump cylinders. When a crankshaft speed of about 10 rpm has been attained, the Diesel engine comes into operation, and it is said that the scheme works very satisfactorily. (*Gas and Oil Power, London*, vol. 27, no. 318, Mar. 3, 1932, p. 53, *d*)

The Delay Period in Oil-Engine Combustion

THIS abstract is based on two papers, one entitled "Some Performances Connected With High-Speed Compression-Ignition Development" and read by C. B. Dicksee on March 1 before the Institution of Automobile Engineers and Associated Societies, and the other entitled "Combustion in Heavy Oil-Engines," by L. J. le Mesurier and R. Stansfield, read Feb. 26, 1932, before the North-East Coast Institution of Engineers and Shipbuilders.

Combustion in the compression-ignition engine is now generally understood to be divided into three stages, viz., (1) a delay period, in which fuel is injected but does not ignite, (2) a rapid rise of pressure due to the initiation of combustion, and (3) a final period in which fuel ignites as it enters the combustion chamber. The ideal condition is for all the fuel to ignite immediately it is injected, because combustion is then completely under the control of the fuel pump; phases (1) and (2) are undesirable because they are out of control. Unfortunately the delay period seems to be inherent, and apparently represents the time required to raise the surface temperature of the oil globules to the self-ignition temperature. Besides removing control from the fuel pump, the delay period gives rise to the objectionable phenomenon of "Diesel knock." Mr. Dicksee's theory—and it seems a reasonable one—is that during the delay period fuel is progressively injected until it reaches the self-ignition temperature, when it detonates, giving in phase (2) a rapid and uncontrolled rise of pressure which causes the knock. Obviously, the shorter the delay period the less fuel will be present at the moment of ignition and the less will be the detonation. Unfortunately from the standpoint of Diesel knock, a higher maximum pressure gives a higher mean effective pressure and a slightly better thermal efficiency. However, the knock is due not so much to the extent of the pressure rise as to its rapidity.

Little is known of the chemical reactions occurring during the delay period, but experiments conducted at temperatures near the self-ignition temperature of the fuel show that after injection the temperature actually falls before rising to a peak on ignition, indicating that heat is abstracted from the air in order to heat the fuel. Calculations show that the delay time is too short to permit the oil globules to be heated throughout, and it is agreed that the globule surfaces only are raised to the requisite temperature, and that ignition commences while the globule cores are still comparatively cold. Evidently the oil does not vaporize completely before it ignites, but combustion proceeds round liquid nuclei.

The authors of both papers have studied the influence of various factors on the delay period, and their points of agreement and disagreement are illuminating. The choice of fuel is found to have an important effect upon the delay period, but how the various properties of a fuel affect its suitability is not agreed. Mr. Dicksee has published some particularly useful information on this point. Arguing from his theory outlined above, he considers that the fuel should have a high-temperature distillation range and a low self-ignition temperature. A fuel with a low-temperature distillation range would result in a large amount of vapor being formed before ignition occurred, so that the charge would detonate. By choosing a fuel with the self-ignition temperature either within or close to the distillation range, ignition occurs before much vapor is formed, and the engine should run smoothly. Experiments conducted by Mr. Dicksee fully corroborate this theory.

As may be expected, a higher air temperature reduces the delay period and conduces to smoother running. An increase in pressure has a similar effect, not only on account of the higher compression temperature thereby generated, but because increasing the pressure lowers the self-ignition temperature and raises the boiling point of a fuel. High-speed engines in particular are often found to run much more smoothly under heavy load than under light load. The roughness under light load is almost certainly due to the reduction of compression temperature. Increasing the injection advance also increases the delay period, because the fuel is injected into air that is colder and less dense. It is still uncertain what effect globule size and turbulence have on delay. Turbulence certainly has an important effect once ignition has commenced, but Messrs. Mesurier and Stansfield consider that it has little or no effect on the delay period except in so far as it causes

the air to take up heat from the combustion-chamber walls. An increase in engine speed fortunately reduces the delay to such an extent that it remains approximately constant in terms of crank angle. This is due to the compression being more nearly adiabatic, and perhaps also to the increased turbulence. Much valuable information on delay is thus now available, but much more is required. Research is all the more necessary because different engines often give conflicting results.

In considering this question one must remember that ignition delay is only part of the problem. The whole delay period consists of two parts, of which ignition delay is the one and injection delay the other. (*The Power Engineer*, vol. 27, no. 313, April, 1932, editorial, pp. 121–122, *tA*)

The Internal-Combustion Turbine

SO FAR the gas turbine as a prime mover has proved little more than an attractive dream, which is ascribed partly to mechanical difficulties, more serious in the gas turbine than in the steam turbine owing to the high temperatures involved, and partly to disabilities inherent in the working cycle. Cost considerations make cylinder compression impracticable for the large volumes of air which must be dealt with if the internal-combustion turbine is to become of any industrial importance. Some form of turbo-compressor is imperative, but such a compressor is poorly adapted for high pressure.

In this connection a question arises as to how the efficiency is to be defined in the case of a turbo-compressor feeding the combustion chamber of a gas turbine. The conclusion to which the author arrives is that, as applied to feeding a gas turbine, it would seem fair to credit a turbo-compressor with an efficiency equal to the ratio of the work theoretically available in the compressed gas to the work exposed in the compression. This, in turn, raises the following question: Should the compressed gas be credited with the work available were it expanded down to its original pressure, or with the work available were it expanded down to its original temperature, and then recompressed isothermally to its original?

In this connection, it may be noted that in some of the recent experimental work of Brown, Boveri & Company, it appears that in certain cases the final temperature of the gases discharged from the turbine under test was below that of the surroundings. This observation is of interest, but such a condition is, of course, one to be avoided, since one definition of the second law of thermodynamics takes the form that no mechanical advantage can ever be gained by cooling any working agent below the temperature of its surroundings.

Theoretically, some compensation for the relatively low initial pressures which alone seem practicable with gas turbines, could be obtained by carrying the expansion down to the ambient temperature and then recompressing the gases isothermally to atmospheric pressure before final discharge. How far this procedure would prove profitable in practice would depend mainly on the efficiency with which this recompression could be effected. The turbo-compressor, though it is well adapted for handling large volumes at low pressures, as would be required in the case considered, is far from an ideal machine for isothermal operations.

Many attempts to use the internal-combustion turbine in combination with the steam turbine have failed. Of late, however, Brown, Boveri & Company have taken advantage of the fact that the gases are discharged from the explosion chamber at high pressure to reduce to a notable extent the size and cost of boiler required for a given output.

Messrs. Brown, Boveri in their experiments have gone up to gas speeds of from 660 to over 1000 ft per sec, and have recorded heat transmissions of more than 110,000 Btu per sq ft per hr. It is claimed accordingly that a boiler capable of providing enough steam for 1000 kw, or, say, 1350 hp, need not have a greater section through its flues than some 24 sq in. With a pressure of $2^1/_2$ atm enough oil has been smokelessly burned in a chamber of 1 cu m capacity to provide steam for an output of 1500 kw, and it is suggested that, working on these lines, the whole of the boiler plant required for a power station might be located in the condenser basement. The gas turbine, which forms part of the plant, only gets its supply after the temperature of the gas has been reduced to manageable limits by passage through the boiler, and the exhaust from the turbine is passed through other heating tubes before being finally discharged. This turbine drives the compressor, and is thus little more than an adjunct to the steam plant. An alternative arrangement is, however, suggested, in which the gas turbine would be the principal power producer and the steam engine and boiler the accessory.

In view of the low initial pressures, the thermodynamic efficiency cannot be expected to rival that of the Diesel engine, but the mechanical efficiency of the latter is relatively so low that there is at present no great gap between the actual thermal efficiencies of the best steam plant and the best Diesel plants. The practical efficiency of the proposed combined plant may therefore be quite as good as that of the best of its rivals, and particulars of actual results will be awaited with much interest.

A similar idea was presented some years ago by the late Prof. J. T. Nicolson, to whose design the boiler was constructed. (Editorial in *Engineering*, vol. 133, no. 3461, May 13, 1932, pp. 575–576, *g*)

Diesel-Engine Pistons

IN THIS mathematical examination of the cause of piston cracks with some remarks on oil for Diesel engines, the author starts with a discussion of the single-acting four-stroke Diesel-engine piston as made by the Werkspoor Company, showing first the design of 1920 and 1921 and then the type used in 1925. The difference lies in the stronger and heavier construction, and the use of fairly elastic bolts instead of short screws.

In the next development the inside webs were omitted so that the load was carried through the circumference to the rod flange. The thickness of the crown was increased and the crown strengthened by two annular webs. To make the design suitable for the existing piston rods, a cast-steel intermediate piece was fitted between the rod and piston as shown in the figure. The design has proved to be good, the only weakness being that after two or three years' service the joint with the intermediate piece has a tendency to leak, showing that the heat at the crown tends to distort the lower part of the piston. A slight cut in a lathe will put matters right.

In the next design the thickness of the crown was increased still more and the intermediate cast-steel piece omitted. This type has been very successful, the only weak point being the connection of the telescopic pipes. By tightening up the nuts for this connection too much, the piston-rod flange was forced open at this place and the joint would start leaking. Afterward the rod flange was milled away at the telescopic pipes, and these were connected directly to the piston. Now, instead, studs near the telescopic pipes may break occasionally.

Another firm developed a design similar to this, but introduced oil cooling of the pistons instead of sea-water cooling, and in the crosshead type they made the oil inlet and outlet through the piston rod so that no telescopic pipes had to be connected with the piston. To make the piston top hotter

so as to avoid all chances of coke deposit, the piston crown was made very thick.

An illustration in the original article shows a Burmeister & Wain trunk piston of the heavy-crown type. Several such

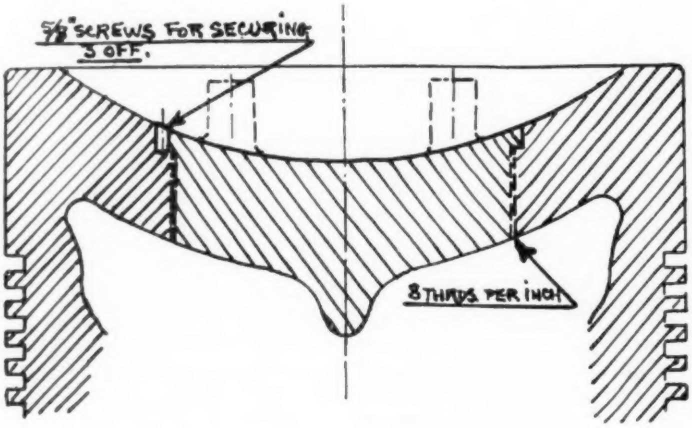


FIG. 1 CRACKED PISTON AS REPAIRED BY A PLUG

pistons cracked during the past two years. They crack in the center of the crown, the cracks starting on the combustion-space side and working gradually down through the material. Crosshead-type pistons have also cracked, but not as frequently.

Cracks in this type of piston are not dangerous. They usually do not go through the whole thickness of the crown. Cracked pistons have been used for one and two years without any sign of the cracks missing.

Fig. 1 shows how the cracked pistons are repaired. A plug of the same thickness and material is screwed into the crown. The plugs seem to stand very well, although they may not always be absolutely tight. The method of repair has been so popular that several new pistons have been supplied with plugs fitted at the beginning.

Fig. 2 is a new design of the trunk piston. The crown thickness has been reduced to 75 mm for 590 mm cylinder bore. Also the top is made loose so that it is not necessary to renew the whole piston if the crown should crack. The design is not very popular among sea-going engineers because of its tendency to collect dirt in the annular space for the nuts. This space should be covered by a ring. Furthermore, also with this type, crowns have cracked, and they have cracked immediately right through. The top part may get slack, and does not seem to be sufficiently rigid. Finally, circumferential cracks have been experienced through one of the ring grooves.

The author discusses next the design of a two-cycle-type piston which was described by Robt. Sulzer in a paper before the Institution of Naval Architects (British) in 1926.

Fig. 3 gives the temperatures which were measured in this type of piston running at 100 rpm under a normal load of about 335 bhp per cylinder. The cylinder bore was 600 mm and the stroke 1060 mm.

The author's experience with this type of piston is that for the larger diameters they have a tendency to crack in the webs inside, in the corners between the crown and the circumference where the temperature is highest (144 C in Fig. 3). The cracking usually comes to the engineer's knowledge because it is followed by a water leakage past the rubber rings in the annular space mentioned above. The cracks seem to deform the piston circumference so much that it does not keep tight against the skirt flange.

The author developed a new design in which all inside webs on the piston crown were omitted, whereby the thickness of the material was increased. The working force had to be carried from the crown through the circumference to the rod flange, the annular gap between the circumference and flange having been bridged. After some months these pistons cracked and the author developed a modified design which has not yet been tested.

The author proceeds next to a discussion of the reasons for the cracking of pistons. This part is not suitable for abstracting. The author claims that a great many of the ships where cracked pistons occurred were using California Diesel oil, and concludes that the oil must be the cause of the trouble. The fuel was a residuum from a cracking process, and is said to be a blended oil.

It has been said by prominent Diesel-engine manufacturers that this oil, when burning, will be decomposed so that the carbon and the hydrogen in the oil will burn separately. The destructive effect of the oil, it is said, will then be due to the intense heat created by the combustion of the hydrogen. It will act like an oxygen-hydrogen flame which will burn right through the iron of the piston crown.

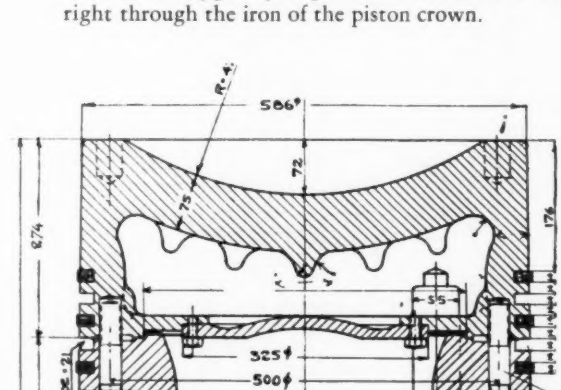


FIG. 2 NEW DESIGN OF A TRUNK PISTON

The author does not agree with this theory. He has seen many cracked pistons, but has not seen any where the crack looked like it had been made by a burning process. Usually, the cracks develop gradually, and it is clear that the material is torn apart by tension stresses. To start with, very often a starlike figure of cracks in different directions is seen in the center of the piston. The biggest crack will develop farther, and may finally go right through.

The result of the Sulzer measurements, viz., that the tempera-

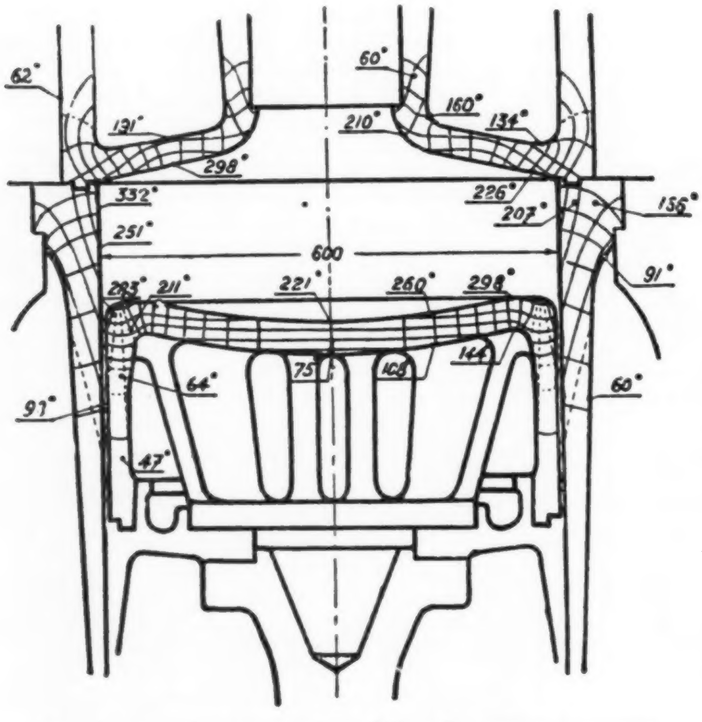


FIG. 3 TWO-CYCLE TYPE PISTON (SULZER) WITH TEMPERATURE DISTRIBUTION

ture at the center of the piston is lower than at the edge, is said to be due to the blast air, which will expand from about 60 kg per sq cm to, say, 35 kg per sq cm just below the fuel valve and will cool the piston here. If this is right, one should not find so many cracked piston crowns with the solid-injection type of motors as with the blast-air type. The author has not sufficient experience with the solid injection type to say if this is actually so, but he hopes that some one with sufficient knowledge will be kind enough to tell. The information the author has looks very promising for the solid-injection type, although it must be remembered that a higher pressure is necessary to give perfect combustion with solid injection than with blast air. And the warmer crowns due to the absence of the blast-air cooling effect may cause circumferential cracks in the ring grooves.

It may not be only the blast air which causes the relatively low temperature at the piston center. The cooling by water or oil is very effective at the center at the same time as the concentration of heavy masses of metal at the edge will cause the accumulation of large quantities of heat here. It might be of advantage to make the piston crown heavier at the center than near the edge.

The author believes that certain oils will cause a higher variation in temperatures in the combustion space than other oils, and therefore may cause higher heat stresses in cracks. (Georg Vedeler in *The British Motorship*, vol. 13, no. 147, May, 1932, pp. 56–60, *cpA*)

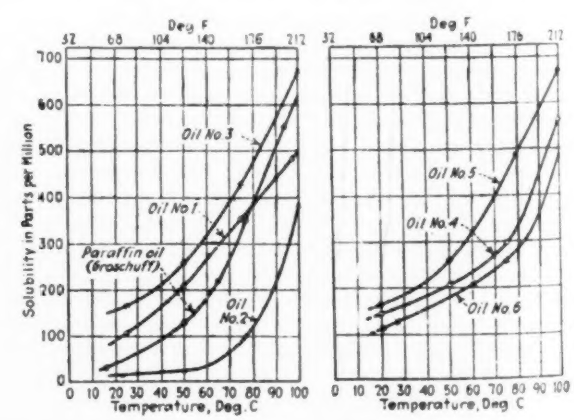
LUBRICATION

Water in Oil

IN THE mechanical purification of oils fairly high temperatures are frequently employed to accelerate the rate at which such purification can be performed. Little or no attention is paid to the fact that at these temperatures it is possible for mineral oils to dissolve a considerable quantity of water, particularly if during such purification the oils are in intimate contact with water. Water dissolved in an oil at a high temperature will precipitate when the oil is cooled and cause a cloudy appearance, which is sometimes erroneously ascribed to the precipitation of wax.

In tests carried out by the authors six unused oils were investigated, including insulating oils, spindle oil, and turbine oils. With the exception of a preliminary centrifuging the oils were given no special purification prior to saturation with water.

The solubility temperature curves for oils Nos. 1, 2, and 3 are given in Fig. 4; those for oils Nos. 4, 5, and 6 are given in Fig. 5. For comparative purposes the data obtained by Groschuff on a paraffin oil with a specific gravity of 0.883 at 18 C (64 F) are also plotted in Fig. 4. Inspection of these curves shows that the solubility of water in oils increases quite rapidly with temperature, and that the oils vary considerably in their ability to dissolve water. At temperatures of 95 C (203 F) or above, the solubility in some of these oils exceeds 620 ppm or 0.062 per cent. In general, the increase in solubility is greatest above 50 C (122 F). Thus, if oil No. 6, saturated with water at 80 C (176 F) is cooled to 50 C, it may be expected to precipitate 110 ppm of water; while in cooling from 50 C (122 F) to 20 C (68 F) it will precipitate 65 ppm. It is evident



FIGS. 4 AND 5 EFFECT OF TEMPERATURE OF OIL UPON THE SOLUBILITY OF WATER

that in the purification and handling of oils in which the possibility of the presence of suspended moisture is detrimental, temperatures should be maintained as low as possible. These temperatures ought certainly not to exceed 50 C (122 F), and should preferably be below 30 C (86 F). This

TABLE 1 PHYSICAL CHARACTERISTICS OF OILS

Oil No.	1	2	3	4	5	6
Description	Insulating	Insulating	Spindle	Turbine	Turbine	Turbine
Specific gravity at 60 F	0.905	0.847	0.916	0.890	0.932	0.913
Flash point, deg F	310	295	295	410	355	350
Fire point, deg F	345	330	330	480	400	395
Pour point, deg F	Below —35	20	Below —35	25	0	Below —25
Saybolt universal viscosity at 100 F, sec	85	52	72	243	307	157
Steam emulsion number, sec	45	13	105	229	251	63
Neutralization number, mg KOH per gram of oil	0.01	0.01	0.01	0.01	0.02	0.01

conclusion is especially applicable to the purification of switch and transformer oils. Partial removal of dissolved water can be effected by passage through carefully dehydrated filter or blotter paper This removal is not effected by a real filtering process, but by absorption of water by the fibers up to some equilibrium value. The amount of water that can be removed by this method is determined chiefly by the increasing degree of saturation of the filter paper as "filtration" progresses. The amount of water that can be absorbed by filter papers is comparatively small, and quickly drops with continued filtration, so that to attempt to compensate for high temperatures of handling oils by a final filtering operation to remove the dissolved moisture is impracticable. Filtration through dried blotter paper will remove some of the dissolved moisture, reducing it to some fraction of the saturation value, but the oil will immediately reabsorb moisture until in equilibrium with the atmospheric humidity. The best results are secured by handling the oils at moderate or low temperatures, using mechanical separation to remove precipitated moisture.

Data are given in the original article to show the extent of removal of dissolved water by dried filter paper. (A. E. Flowers and M. A. Dietrich in *Mechanical World*, vol. 91, no. 2362, Apr. 8, 1932, p. 336, 2 figs., *e*)

MACHINE PARTS (See also Testing and Measurements: Rivet Testing)

Ball and Roller Bearings of Sliding Mechanisms

THE advantages of ball and roller bearings in certain applications have long been recognized by engineers, but hitherto such bearings have only been available for supporting loads perpendicular to the axis of rotation of the shaft, or, as thrust bearings, to take an axial load. In the drawings in this article, there are illustrated forms of roller and ball bearings suitable for sliding mechanisms. The device, which employs the sun and planet principle, has been developed by the Hoffmann Manufacturing Company, Ltd., of Chelmsford, England. Referring to Fig. 6, which shows the invention in its simplest form, it will be seen that the load of a sliding member can be carried by the large ball *A*, which partially projects through a hole in the cover of a cylindrical box. The hole within which it is situated is eccentrically placed with regard to the axis of the box. Within the box the large ball *A* rests in a raceway *B*, itself supported by the ball thrust race *C*. The raceway *B* is circular. Thus, when the sliding member passes over the large ball *A*, the latter rotates, driving the raceway *B* on its thrust bearing. In this way an almost frictionless sliding bearing is provided.

The application of the principle so that use can be made of a roller instead of a ball for supporting the sliding member involves slightly more complication. Within the box—see lower left-hand section of Fig. 6—the roller is supported on two concentric races, which are independent the one of the other. Thus the inner race can revolve more rapidly than the outer. It is necessary that it should be able to do so, because the inner edge of the roller is nearer the axis of rotation of the races. It will be observed that in both the applications described the races are completely enclosed in the box, which can be provided with means for pressure lubrication. Both types are quite shallow in proportion to their load-carrying capacities. For a load of 7500 lb, for instance, a device with an overall depth of only $2^3/_8$ in. would be required.

The application illustrated in the two drawings at the right in Fig. 6, although more complicated, is of considerable interest. In this case a large roller is disposed right across a diameter of the box enclosing the races. It is not placed eccentrically. The roller is provided with two shoulders at each end and is supported on two races. The outer shoulder is supported at one end by the outer race, which is clear of it at the other end, where the inner race supports the inner shoulder, but clears it at the first-mentioned end. To take any side thrust the inner ball race is held in position axially by a third journal ball bearing. It will be seen that the large roller can be rotated about a vertical axis, and has, in fact, a

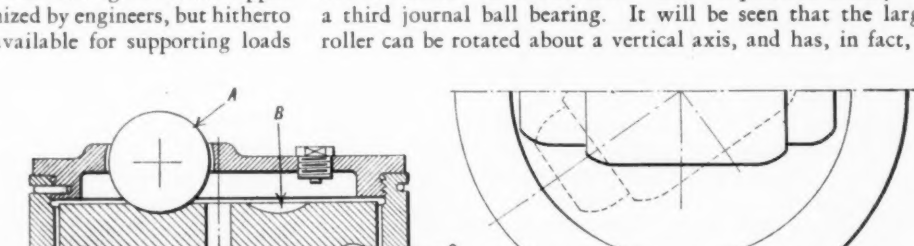


FIG. 6 BALL AND ROLLER BEARINGS FOR SLIDING MECHANISMS

caster action. We shall leave our readers to think out many of the possible applications of this new device. (*The Engineer*, vol. 153, no. 3985, May 27, 1932, p. 593, 4 figs., *d*)

MACHINE-SHOP PRACTICE

Tungsten and Tantalum Carbide Cutting Tools

TUNGSTEN CARBIDE tool material consists of tungsten carbide in a matrix of about 6 per cent cobalt bond, cobalt being used for this purpose because it is one of the few high-melting-point materials that will not carbonize and will not therefore steal the carbon from the tungsten carbide and so weaken it. Cemented tungsten carbide will withstand great heat and will, in fact, cut while at a red heat. Tungsten has an affinity for steel and cannot be used for cutting it. This difficulty has been overcome by the introduction of tantalum carbide, tantalum having no affinity for steel.

While the cutting carbides can cut at many times the speed

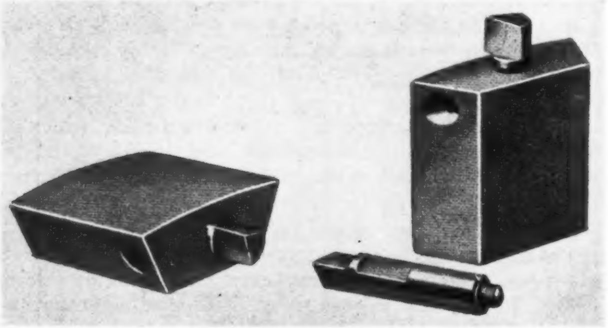


FIG. 7 ALUMINUM BLOCKS HOLDING CUTTING-CARBIDE TOOLS ON A GRINDING WHEEL USED FOR MILLING

possible with high-speed tools, it does not always pay to use these very high speeds, it being preferable to use the medium speeds and reap the advantages of longer life between grinds. In the original article is given a table of average speeds for normal conditions. When scale is present on cast iron, cutting should start at a lower speed, and when the tool has cut under the scale, the speed should be increased.

When working on certain materials, such as steel, cutting-carbide tools are liable to produce so many cuttings in long coils and at such a speed that the cuttings are liable to curl around the machine, so embarrassing the operator. For this reason it is desirable that chip breakers be fitted. One way of breaking the chips is to provide a step in the tool against which the chip will strike, and so be broken; but this is not always feasible, as the shape of the tool may be against such provision, so that often the chip breaker must be a separate piece fixed on top of the tool in such a manner as to break the chip or curl it away from the workman. The chip breakers can also often be arranged so that they curl the chips into compact coils like clock springs instead of snake-like cuttings.

One firm tried fitting a pair of shears which automatically opened and closed, so cutting the cuttings as they passed between the blades, but with what success is not known. Another way of getting the cuttings away is to divert them into a pipe, through which they pass out of the way of the operator.

It is advisable to reduce the cutting speed in order to avoid the difficulty presented by the curling cuttings.

A rather interesting application of cutting carbides to the milling of aluminum switchboxes at the works of the English Electric Company at Stafford is illustrated in Fig. 7. The abrasive segments of a grinding wheel were replaced by aluminum blocks, each carrying a Widia-tipped cutter, which are in use cutting at the maximum speed and feed obtainable on the machine—6200 ft per min, with a table feed of 7 ft per min. The machine time is one-sixth of the time previously taken for grinding, and the tools show little or no signs of wear after operating for a considerable time, whereas previously one set of abrasive blocks, costing about one-third that of the Widia tools, were completely worn out on each batch. Planing machines should be fitted with a means for lifting the clapper box on the return stroke, otherwise the tool edge will be broken by dragging over the surface. One way of lifting the clapper is by a pneumatic piston; another is by magnetic means. (H. Shaw in *Mechanical World*, vol. 91, no. 2368, May 20, 1932, pp. 490–494, 7 figs., *dp*)

MACHINE TOOLS

Machine Tools and Russia

AT THE annual meeting and dinner of the Machine Tool Trades Association held in London on March 23, 1932, it was stated that 60 per cent of the exports of the members of the association in 1931 went to Russia. This work is being done on the basis of long-term credits for Russian purchasers, but sales of products by Russia in England are made for cash. It is stated that on the face of it this arrangement has not appealed to the British authorities as a fair one, and even the president of the Machine Tool Trades Association apparently holds that opinion. It is further stated that those who went to the Leipzig Fair early in the year were impressed with the amount of business in machine tools being done by Germany with Russia. Representations made by the Machine Tool Trades Association with the view of securing Government assistance in the grant of long-term credit to Russia did not appear to have had the desired effect in high quarters of the British Government. (Editorial in *Mechanical World*, vol. 91, no. 2362, April 8, 1932, pp. 333–334, *g*)

METALLURGY

Iron-Boron Alloys and 18–8 Steels With Boron

TESTS made some years ago at the U. S. Bureau of Mines showed that some iron-boron alloys have the remarkable property of remaining in the plastic stage for a considerable time after passing the usual solidification temperatures. However, this paper deals primarily with the age hardening of boron-containing alloys. According to previous investigators the iron-boron system belongs to a group that exhibits a contracted gamma region. The A_3 point is raised by boron and the A_4 point lowered at the same time. Alloys of this type were hitherto not supposed to be amenable to precipitation hardening, but in the tests carried out here contrary results were obtained. These tests were carried out on an extended series of iron-boron alloys with various methods of quenching. When boron steels were allowed with about 2 per cent manganese, a pronounced quench-hardening effect was observed. An increase of the Brinell hardness is observable similar to normal martensite hardening, but subsequent annealing produced softening, increasingly so with increasing tempering temperature. In order to completely restore the hardened material to the soft condition, a temperature of 700 C is generally required. These experiments show that the addition of manganese causes a widening of the gamma region,

which means that it increases the dissolving power of the gamma iron for boron and so sets up conditions similar to those obtaining in the case of iron-carbon alloys, with the result that quenching produces a hardening that resembles martensitic hardening, while tempering causes a corresponding softening of the material.

Additions of nickel and nickel-chromium have been tried with iron-boron alloys. The behavior of these steels differed entirely from the manganese-bearing steels referred to above. No appreciable quench hardening occurred with any of them. A slight increase in hardness was found, however, with increasing boron content, but subsequent annealing produced pronounced precipitation hardening in all these steels. The behavior of boron steels containing silicon was found on treatment to resemble that of the other binary boron steels. As a general conclusion it may be said that the investigation has shown that both quench hardening and precipitation hardening are likely to occur with iron-boron alloys. The two kinds of hardening apparently differ only in so far as the degree of supersaturation is concerned.

The influence of the rate of cooling during the quenching process on the hardening phenomena of iron-boron alloys is next discussed. It was found that the most drastically quenched samples showed the highest degree of hardening, whereas the slowly cooled samples had lost the capacity for precipitation hardening. Certain of the boron-iron alloys lend themselves apparently both to precipitation hardening and to quench hardening. Data on some physical properties of age-hardening chromium-nickel-boron steels are given. The aging treatment seems to result in a lowering of the impact strength. In some cases, however, the boron content caused a conspicuous increase in yield point and tensile strength. (Dr. R. Wasmuht, Krupp Research Laboratories, Essen, Germany, in *Metals and Alloys*, vol. 3, no. 4, April, 1932, pp. 105–110, 23 figs., *e*)

MOTOR-CAR ENGINEERING

A Diesel-Engined Automobile

IN THIS case a Gardner Diesel engine was installed on a 1925 Bentley car. The engine has four cylinders, $4^1/_4$ in. bore × 6 in. stroke, is equipped with Bosch fuel pumps and Gardner injectors, and is capable of developing about 68 bhp at 1700 rpm. The engine weighs 975 lb and burns Diesel fuel oil at the rate of 30 to 37 miles per gallon. The vehicle has a speed range from 8 to 80 mph on the top gear.

The two existing fuel tanks of 16 gal total capacity will run the car for about 500 miles without replenishment. The conversion is not a commercial undertaking. (*Gas and Oil Power*, vol. 27, no. 318, Mar., 1932, pp. 57–58, and illustration on p. 68, *d*)

PIPE (See also Special Processes: Welded-Pipe Manufacture)

Large-Diameter Natural-Gas Transmission Lines

AFTER pointing out the advance in methods of manufacturing of pipe, the author of the article here abstracted says that perhaps the largest contribution made to the advancement of gas transmission comes from the increase in the allowable working pressure for large-diameter pipe. With the increasingly higher carbon steels now being used, considerable reduction in weight for a given diameter and working pressure may be expected.

Another advantage brought about with this new process is the complete absence of mill scale, both inside and outside the pipe. This reduces the abrasion on regulator valves caused by the scale formerly loosened from the inside, and gives a much cleaner and better surface on the outside, improving the application of protective coatings. Again science and engineering have helped to a very large degree in perfecting sturdy yet portable and fast machinery to assist in the actual field work of laying these large lines.

There are at present three different methods of joining the lengths of pipe received from the mill into a continuous line from the field to the distant market. Sometimes a combination of all three may be used on the same line, depending on the character of the country traversed. Couplings using rubber gaskets to make the joint gastight are used quite extensively. These rubbers must be of special composition to insure that they remain resilient for the life of the line. Oxyacetylene-welded joints are becoming increasingly popular with the advancement that has come about during the past few years in the technique of this method. Comparatively recent improvements in the application of oxyacetylene welding have increased by many times the speed of completing a joint. The third method, also used extensively, is known as electric-arc welding. These two methods of welding joints, properly applied, will produce a joint that is stronger than the pipe. In California, where there is only a small difference between seasonal maximum and minimum ground temperatures at pipe depths, solid welded lines as large as 26 in. in diameter have been laid successfully. It is difficult to provide the necessary slack to relieve the strain produced by wide variations of temperature, and under this condition it is common practice to provide expansion joints or rubber couplings at regular intervals between welded sections.

In some territories chemicals contained in soil and drainage water are very corrosive to steel pipe. Instruments are now available which indicate the electric resistivity of soil, and this can be translated into degrees of corrosiveness. Some progress has been made in recent years in the quality and effectiveness of protective applications, which has brought about a considerable increase in the useful life of steel pipe lines.

The obstacles of construction, such as rivers, are discussed. Reference is made to the largest suspension bridge used exclusively for carrying a pipe line. This bridge has been recently completed across the Missouri River near Sioux City, Iowa, and has a clear span between towers of 1280 ft supporting a 16-in. solid welded line over 50 ft above high water level.

There seems to be some apprehension among engineers as to the relative cost of multiple-line crossings and bridge crossings. In a great many cases these bridges cost less than multiple-line crossings, and they are usually designed to carry duplicate lines at some future date when required, which makes them very much less expensive if duplicate under-river crossings are required to provide additional carrying capacity. If the cost were the same, the savings accruing from the maintenance of under-river crossings as against bridges is an item worth serious consideration. From an operating standpoint the security acquired from bridge crossings insuring continuous service is also very important.

Large transmission lines extending from fields to great cities require their own telephone lines. The dispatching of gas is not dissimilar to the dispatching of trains. The operating efficiency is greatly increased by means of faster communication, permitting the dispatcher to have close contact at all times with the field department and compressor stations. He is constantly in touch with pressure conditions all over the

system, and can regulate the supply of gas according to the demand.

These large lines, operating at peak capacity, transport gas at velocities of nearly 100 mph. It will be observed, therefore, that in the short span of 10 to 12 hours gas may be taken from the fields to the burners of the consumer, a distance of 1000 miles or more. It is a well-known fact, however, that the consumer need not wait for delivery of his requirements, for it is always available to him instantly. (Elmer F. Schmidt, Lone Star Gas Co., Dallas, Tex., in *Gas Age-Record*, vol. 69, no. 20, May 14, 1932, pp. 595–598 and 617–618, 5 figs., *d*)

POWER-PLANT ENGINEERING

Heat Transfer by Radiation in Boiler Furnaces

THE original article gives the theory of heat transfer by radiation as well as data of an elaborate series of experiments. An interesting part is that dealing with the distribution of losses in the furnace as well as with the determination of the surface temperature on the grate. One part of the article deals with the heat radiation in the furnace from the grate and brickwork as well as the radiation from the gas. The measurement of flue-gas temperatures in the furnace and passages of a sectional header boiler have been carried out by suction pyrometers in the course of the ordinary acceptance testing and without any special installation. A simultaneous use of several suction pyrometers for the determination of instantaneous temperature regions has been carried on without any trouble. In this way a clear picture of the distribution of temperatures of the flue gases along the path of their flow through the boiler and the variations of temperature across the width of the boiler has been obtained. Methods for the determination of the coefficient of heat transfer in boiler passages in the higher flue-gas-temperature range have been worked out, permitting these temperatures to be determined without much trouble. The surface temperatures of the fuel bed have been approximately determined. The high values of grate temperature must be ascribed to the action of the compressed air of combustion driven through the bed of coal. It has been found that the total amount of heat transfer by radiation in the furnace was at normal load 32.5 per cent and at peak load 31.3 per cent of the total heat generated in the furnace (coal and air). The radiant heat therefore accounted for 38.4 and 37.3 per cent, respectively, of the heat required for the purposes of steam generation. Because of its comparatively small radiating surface, the grate contributed only 9.6 and 11.3 per cent of the total radiant heat. Radiation from the furnace walls, because of their greater surface, accounted for 36.7 and 39.8 per cent of the radiant heat, while radiation from the gases in the furnace contributed 27.3 and 27.2 per cent. The particles of soot and coke dust floating in the flame are accredited with 26.4 and 21.6 per cent. It would appear, therefore, that for boilers of small and medium size a comparatively large furnace is an appropriate means of reducing high furnace temperatures due to heat radiation. Particular importance is ascribed to large furnace walls inclined at a favorable angle of radiation to the heating surfaces. It would appear, therefore, that water- and air-cooled furnace walls should be avoided, and that only those walls need to be provided with cooling surfaces which are exposed to the highest grate temperatures and are operating at an unfavorable angle of radiation.

The formula given by Orrok for the calculation of radiant heat of furnaces has been found to be in good agreement with experimental data. The determination of average furnace temperatures by the graphic process of Münzinger gave for the boilers investigated in this case values somewhat higher than those determined experimentally. (Hans Friedrich in *Mitteilungen aus den Forschungsanstalten*, vol. 1, no. 10, March, 1932, pp. 227–243, 15 figs., *eA*)

Boiler Sludge as a Source of Danger

THE author claims that while great attention has been paid to the subject of boiler-scale formation, not enough thought has been devoted to the subject of boiler sludge, and yet the latter constitutes a source of real danger and a potential cause of trouble in the operation of a boiler. Where feedwater contains salts in solution, it is generally subjected to some kind of a treatment, usually chemical, either in the boiler or outside thereof. The treatment commonly consists in converting the salts held in solution in the feedwater into insoluble salts, which are then precipitated in some way, and the author shows that wherever soda is used as a water softener the chemical reactions are such as to lead to the formation of caustic soda, NaOH, and carbon dioxide in the boiler water, this being accompanied by the formation of a sludge, particularly when an excess of soda is present.

The harmful influence of caustic soda is well known, but that of carbon dioxide has not been realized to the extent which it deserves. This carbon dioxide is present in the form of tiny bubbles of gas adhering to the surface of the boiler and protected from being washed away through the water circulation by the film of sludge. The newest investigations, for example, by E. Claussen ("Entstehung und Verhütung des Kesselsteins," Berlin, 1920), show that carbon dioxide in boiling water is capable of attacking iron even when no air or oxygen is present, and according to the investigations of Just and Engler, iron carbonate is produced accompanied by the evolution of hydrogen. When the water contains oxygen from the air, as is practically always the case, the heating intensifies the action of the bubbles of the carbon dioxide, in that it produces a separation of the iron from the ferrocarbonate in the form of an oxyhydrate, liberating in the course of the reaction the carbon dioxide and thus providing material for a further attack on the iron. Where the bubbles of carbon dioxide are held in place by the film of sludge adhering to the boiler wall, there appears at first a spongy blanket of decomposed iron which first grows and then crumbles up, leaving behind it a spot eaten out to a depth sometimes as great as 4 to 5 mm. (0.157 to 0.196 in.). It is hardly necessary to add that such removal of metal decreases the strength of the boiler wall. A photograph in the original article shows how extensive the attack of carbon dioxide on iron may become. The fact that such attacks on the metal occur is, of course, known to every boiler operator, but the author says their cause has not been well understood in the past. The formation of caustic soda and carbon dioxide is particularly active when soda is introduced into the feedwater tank or directly into the boiler, because in that case, first, much more sludge is formed, and next, there is a possibility of an excess of soda being present, which in turn increases the formation of caustic soda and carbon dioxide. Many of the preventives of boiler-scale formation introduced directly into the boiler water contain soda, which may reach the boiler in this way. Soda is not, however, the only one of the boiler softeners which can cause formation of carbon dioxide. According to an investigation by Splittgerber, soda may be broken into caustic soda and carbon dioxide by hydrolysis even at comparatively low boiler pressures, namely, 3 atm, and at temperatures of 80 C at 15 atm, and 90 C at 20 atm. It must be further remembered that even when no chemical additions

are made to unpurified feedwater (raw water), a powerful evolution of carbon dioxide takes place simultaneously with the formation of sludge. This is developed from calcium bicarbonate, which on heating in the boiler feedwater, is broken up as a result of purely a thermal process into calcium carbonate and carbon dioxide. This thermal break-up takes place in accordance with the following equation:

$$Ca(HCO_3)_2 = CaCO_3 + H_2O + CO_2$$

With this reaction carbon dioxide is liberated, and the bubbles of it in a nascent state either adhere to the particles of the calcium salt or else are surrounded by the particles of the salt, and with them sink to the bottom of the boiler. Where the carbon dioxide scatters through a film of sludge, it exercises its destructive effects against the boiler material.

Feedwater also often contains magnesium chloride. This can be broken up by hydrolysis into magnesium oxide and hydrochloric acid. When this takes place the harmful effect of the hydrochloric acid is added to the other effects, and here again the presence of a film of sludge is essential.

In addition to acting as a contributory cause of chemical corrosion, boiler sludge is apt to produce electrochemical or electrolytic corrosion. In all metals, with the exception of the noble metals, all deposits produce galvanic attack. Due to the action of oxygen, free and otherwise unaffected metal surfaces become rapidly covered with an infinitely thin protective layer which makes the metals electrochemically passive. On metal surfaces covered by sludge no such protective layer can maintain itself, with the result that the metal surface becomes active. As between the surfaces covered by sludge and those free from sludge there is an electrical potential difference, and since boiler water is always slightly acid, electrically a galvanic element is created with the result that the active metal surface (the one covered with sludge) acts as an anode and goes into solution, while the surface not covered with sludge becomes a cathode. This phenomenon can be very well observed on some radiators for automobile engines, where holes eaten out of the metal are often found after washing out the sludge.

The author gives an analysis of boiler sludge taken from an article of G. Schmidt in *Die Warme*, 1931, p. 948. A striking factor of this analysis is the high content of rust, Fe_2O_3, namely, 12.28 per cent. The content of iron oxide in the raw feedwater was considerably less, which can be explained only by the fact of attack on the boiler material by the carbon dioxide. Other instances of attack on boiler material are cited in the original article.

A further danger of sludge in boilers lies in the fact that sludge is apt to plug up the water-level glass and thus indirectly lead to an explosion. At the central station at Mannheim it was found after removal of the scale by additions of phosphate to the feedwater that some of the sludge was burned solid on to the heating surfaces and caused a considerable amount of injury to the tubing. (Hans Richter, Hamburg, in *Chemiker Zeitung*, vol. 56, nos. 18 and 20, Mar. 2 and 9, 1932, pp. 173–174 and 195, 1 fig., *p*)

PUMPS

Operation Costs of Diesel-Driven Centrifugal Units

THE Diesel centrifugal unit with the gear increaser has come into service with the development of the higher speed Diesel engine. Such a Diesel-driven centrifugal unit has been installed by one of the principal oil-pipe-line companies. The engine is a 300-hp vertical, six-cylinder, four-cycle, solid-injection type, 750-rpm machine which is direct-connected through a flexible coupling to a single-pinion gear increaser of 4.73 to 1 ratio. The high-speed shaft of the gear increaser is direct-connected through a second flexible coupling to a 6-in. four-stage centrifugal pump operating at 3550 rpm. The capacity of the pump is 25,000 bbl per day at 450 lb per sq in. line pressure.

An all-steel building 20 ft wide by 34 ft long houses the unit with ample room on all sides, the total length of the unit being approximately 22 ft. The unit weighs 22,000 lb, of which the engine weighs about half. Thus, one can see the advantage of portability when used in remote places or for temporary installations which can be made in four to six days. The manufacturers point out that with the use of I-beams instead of a concrete foundation, the installation can actually be made and placed in operation in from 24 to 48 hr.

The water system for jacket cooling consists of a $2^1/_2$-in. centrifugal pump mounted directly on the engine and driven from the engine crankshaft and two 1600-bbl steel tanks for water storage. However, on future installations a heat exchanger in either the oil suction or discharge line will be used, cooling the jacket water with crude oil, which is a much cheaper and more efficient system. This system of cooling is particularly desirable for installations where water is scarce or is of such a nature that it is not desirable for jacket cooling. As with the closed system, the engine can be operated on a small amount of soft water. The overall mechanical efficiency is rather low in comparison with electric-motor drive. (J. B. Harshman, Stanolind Pipe Line Co., in a paper before the Mid-Continent Section of The American Society of Mechanical Engineers, Mar. 10, 1932, Tulsa, Okla. Abstracted through *The Oil Weekly*, vol. 65, no. 1, Mar. 18, 1932, pp. 49–50, 1 fig., *c*)

RAILROAD ENGINEERING (See Internal-Combustion Engineering: Italian Diesel-Locomotive Practice)

REFRIGERATION

Solid Carbon Dioxide in Industrial Refrigeration

THE cost of solid carbon dioxide as compared with mechanical refrigeration is relatively high, but the results to be secured through its use are more strictly comparable with those secured from the much more expensive liquid air. Where extremely low temperatures are required, solid carbon dioxide offers a ready means of producing them. Although the subliming temperature given at a pressure of one atmosphere pressure of carbon dioxide is well below most industrial requirements, by causing the solid to sublime in a space where the pressure is reduced below an atmosphere, even lower temperatures may be produced. If, on the other hand, a control of temperature at some higher value is required, a control of the pressure of gas over the solid carbon dioxide will, within limits, result in such a control. The practical lower limit of temperature of sublimation is in the neighborhood of —165 F, and the upper limit is the triple point of carbon dioxide where sublimation ceases and true melting begins. This point is about 75 lb pressure and —70 F. In other words, by the use of vacuum and pressure the sublimation temperature of solid carbon dioxide can be varied over a low range of some 85 F and can be controlled with considerable accuracy at any desired point within that range. Above —72 F, where melting begins, the control of pressure is not an accurate temperature control except of the boiling of the liquid melted from the solid.

Illustrative of extreme low-temperature operation is the application of solid carbon dioxide to replace or to supplement liquid air in the production of high vacuums.

The easy portability of a small unit refrigerated by solid carbon dioxide has found ready acceptance in the fabrication of the light alloys of aluminum. Annealing of aluminum-alloy rivets must be carefully done to insure their softness when driven, and peculiarly enough, ordinary temperatures are high enough to harden them, however carefully annealed, in so short a space as half an hour. The inconvenience of reannealing rivets at half-hourly intervals can be avoided only by keeping them at very low temperatures after the treatment. This is accomplished in many of the shops fabricating materials of this sort by providing each riveter with a small box refrigerated by solid carbon dioxide. (D. H. Killeffer, New York, in *Industrial and Engineering Chemistry*, vol. 24, no. 6, June, 1932, pp. 615–616, *p*)

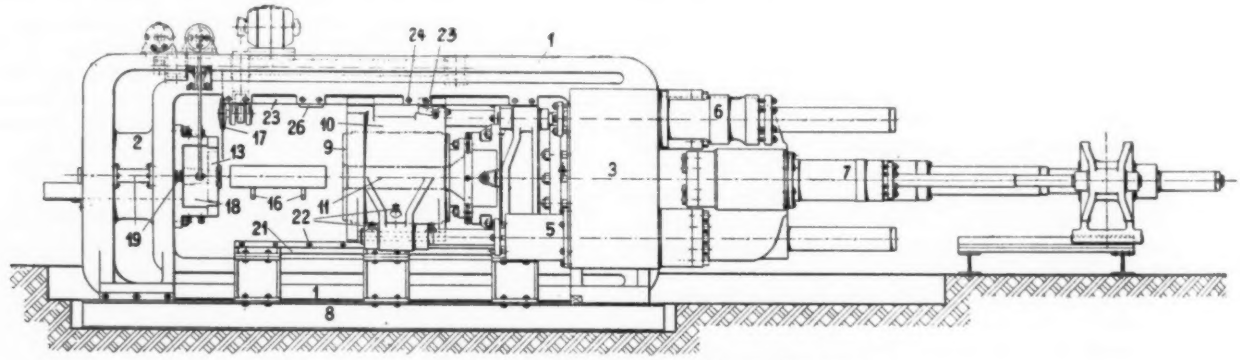
SPECIAL MACHINERY

The Krupp Extrusion Press

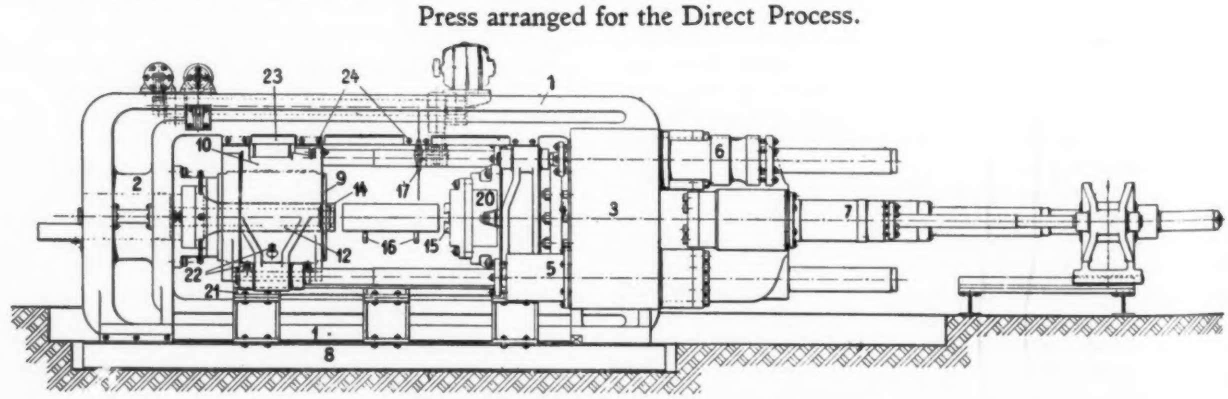
THIS press built by Fried. Krupp, Grusonwerk, in Germany, is intended to operate either by the direct or by the inverted process of extrusion. The most noteworthy features of this press (Fig. 8) are its movable container (9) and the way in which the billet is introduced.

When operating by the direct process, the extruding ram (11) is attached to the main ram (4), the die being fitted in the head (2) of the press. When extruding by the inverted process the main ram carries a pressure block (15) to take the thrust on the rear end of the billet, while the hollow extruding ram with die holder (13) is fitted to the head of the press frame. Even when at first only the direct process is to be employed, the press, nevertheless, is so arranged that the devices required for the inverted process can easily be fitted at a later date.

In either case the billet is introduced from the side—with the direct process into the space between die holder (13) and ram (11), and with the inverted process between the pressure block (15) and the hollow ram. While the billet is being introduced the movable container (9) is slid over the extruding ram. The same details are given for working from a solid billet and a hollow cylindrical billet. In extruding rods by the inverted process, the billet is introduced and the container (9) brought over it. Die holder (14) and die are fitted into the free end of the hollow ram. On the main ram forcing forward container and billet together, the billet is extruded through the hollow ram as the latter enters the container. (*The Metal Industry* (London), vol. 40, no. 18, Apr. 29, 1932, pp. 470–473, 2 figs., *d*)



Press arranged for the Direct Process.



Press arranged for the Inverted Process.

1. Press frame.
2. Head of press frame.
3. Main press cylinder.
4. Main ram.
5. Cylinders for traversing container.
6. Retractor cylinders (for main ram).
7. Tube extrusion equipment.
8. Foundation frame.
9. Container.
10. Container jacket.
11. Extruding ram for the direct process.
12. Extruding ram for the inverted process.
13. Die holder for the direct process.
14. Die holder for the inverted process.
15. Pressure block.
16. Billet charger arms.
17. Pivoted saw.
18. Transverse locking plate with die holder.
19. Die-ejecting device.
20. Transverse locking plate with pressure block.
21. Longitudinal tracks.
22. Adjusting screws.
23. Slide rods.
24. Adjusting screws to 23.
25. Adjustable ramps.
26. Contact pieces.

FIG. 8 KRUPP HORIZONTAL-TYPE EXTRUSION PRESS

SPECIAL PROCESSES

Grinding-Plant Research

THIS is a serial article, and the part here abstracted deals with tests of coal-grinding mills, and primarily with English practice in cement plants.

The machines used for coal grinding at most of the English cement plants during the test periods were kominors and tube mills or compound tube mills, though Griffin mills and Bradley three-roll mills were also used. Data on the kominor and tube mills used in this test are given in the original article. In the kominor, stepped lining plates of the standard type were used with a minimum inside diameter of $62^3/_4$ in. and a maximum diameter of $74^1/_4$ in., with a charge of steel balls ranging from 1.58 to 2.58 in. in diameter. In the tube-mill flint-stone chamber the charge consisted of flints which ranged from 28 to 1.3 oz in weight, the average being 6.8 oz. There was a diaphragm plate between the flint-stone chamber and the "cylpeb" chamber. The charge in the cylpeb consisted of cylpebs mainly $^9/_{16}$ in. in diameter and $^{13}/_{16}$ in. long, with an average weight of 0.9 oz. The coal, bituminous slack, contained 19.5 per cent of ash and 2.2 per cent of moisture, ground.

Data of output are given in the original article, as well as curves of grinding results where the abscissas are brake horsepower per ton ground per hour and the ordinates are sieve residues in percentages. The curves cover both the kominor and the flints and cylpebs of the tube mill, and are given for 76, 100, and 180 mesh.

From Table 4 and Fig. 16 in the original article (not reproduced here) it appears that the coal entering the kominor had an average residue of 98.6 on 180 mesh, and the coal leaving the tube mill an average residue of 13 per cent on 180 mesh.

Formulas for obtaining power for the mills are given in the original article. The relative efficiencies of the mills are formulated, and if that of the kominor is taken as 100 the efficiency of the tube mill is 83.5. The overall efficiency of the cylpeb chamber is somewhat less than that of the flint stone chamber. These tests were carried out at the Wouldham Works of the British Portland Cement Manufacturers, Ltd., Grays, Essex. A second series of tests are reported as made at the Wilmington, Hull Works, of G. and T. Earle, Ltd., on a kominor and a tube mill. In this case in one chamber flints were used and in another "holpebs" and "helipebs." Here the efficiencies of the flint-stone chamber appear to be slightly greater than that of the kominor or of the helipeb chamber but the reference line refers to the grinding of standard size of uniform hardness, and not coal. The mill generally gave a poor result because most of the balls in the kominor ($1^3/_8$-in., $2^1/_4$-in. and $4^3/_8$-in.) were far too large, and for coal which had been screened through 10-mesh most of the flints in the tube mill also were far too large. The flints ranged from $^7/_8$ to $9^1/_4$ oz in weight, the average size being $3^1/_2$ oz. (One instalment of a serial article (not completed) by Wm. Gilbert in *Rock Products*, vol. 35, no. 8, Apr. 23, 1932, pp. 40–43, 4 illustrations, *e*)

Welded-Pipe Manufacture

A MODERNIZED mill has recently been completed for the manufacture of pipe by welding by the Fretz-Moon Tube Company at Butler, Pa. The mill is operated continuously and smoothly by using skelp in coils ranging from 300 to 1500 ft in length, and by welding one coil to the next. This skelp ranges from $1^9/_{32}$ in. to $9^1/_4$ in. in width and from 0.065 to 0.154 in. in thickness, while the resulting conduit runs from $^1/_8$ to $2\ ^1/_2$ in. in diameter.

To maintain continuity in mill operation during the welding, a device patterned after the take-up loop in the motion-picture machine is employed, the strip skelp being looped out on to a special runway to supply the furnace during the momentary pause for joining. After passing through the leveler the weld is so perfect as to be hardly discernible.

The seam-welding furnace that the skelp now passes through is radically different from other pipe furnaces in that it is much smaller in cross-section, different in design, and more effective in heat transfer. The principal thought in the design of this furnace was to concentrate the heat on the edges of the skelp, as the body of the skelp needs a bending heat only, and this was accomplished by placing a long row of gas burners in each side of the furnace so that they would fire against the edges of the skelp as it passed through. The speed at which the skelp moves runs from 150 to 225 ft per min, depending upon its weight.

The furnace is 125 ft long, and the hot skelp is pulled along over a series of water-cooled skids. As the concentration of the heat application was the most important factor, the heating chamber proper is only 11 in. wide and 14 in. high, and the burners are fired through bell-mouthed refractory tunnels so that the heat transfer is through convection, radiation, and flame impingement. These tunnels as well as the lining of the furnace are constructed of sillimanite, which will stand a temperature of 3300 F. The method by which the edges of the skelp are stepped up to full welding heat outside the furnace is said to be novel. As the strip steel emerges from the furnace it passes through forming rolls which give it the round shape of pipe with the edges in close contact. They require just a little more heat for welding, and this is obtained by playing a jet of air on the hot edges. The reaction of the oxygen of the air and the carbon of the steel brings the temperature from 2500 to 2600 up to around 2800 F, and the skelp passes directly into a set of rolls which press the edges together into a perfect welded seam. The pipe then passes through several sets of sizing rolls which true it up to its final shape and diameter. It is now cut up into lengths by a high-speed rotary saw mounted on a traveling carriage, which moves along at the same speed as the conduit while it is sawing through, and then returns for the next cut. Unlike the usual practice the galvanizing tanks are heated not from the bottom but with burners set about $1^1/_2$ ft below the top. The design of the heating and details of dipping are described in the original article. (J. B. Nealey, American Gas Association, in *American Gas Association Monthly*, vol. 14, no. 3, March, 1932, pp. 108–110, 4 figs., *d*)

The "Typing" Process of Making Forging Dies

THE engineers of the Ford Motor Company have developed a process by means of which a hardened master die is driven into a heated block of steel. By this method the cost of forged and trimming dies has been considerably reduced. Some of the smaller dies are typed in punch presses with capacities ranging from 400 to 600 tons. Pieces of steel of suitable size are heated to a temperature of 1700 F in a lead pot. One of the heated steel blocks is placed in a retaining ring and pushed into place directly under the master type, which is mounted in the ram of the press. The master type is then forced into the heated billet.

Some parts, however, as, for instance, the star punch for the gasoline gage nut, require a somewhat different process. In this case the master type consists of a ring with a star impression worked out in the center just enough larger than the punch required to allow for shrinkage. This is placed on the bed of the press and a flat piece mounted in the ram. When

the billet is put in place and the press tripped, the billet is driven into the master die.

On the larger dies a 2500-lb steam hammer is used. The type consists of a set of hammer die blocks. In the bottom block a cavity is machined to approximately one-half of the thickness of the die to be made. The top block is machined in a similar manner, except that the cavity is in the bottom of the block. The cavities retain the heated metal and cause it to flow up and around the master, filling in sharp corners and various intricate places. In some cases when difficulty is experienced in filling corners or small projections in the dies, to be typed, it is necessary to drill vent holes in the master dies thus permitting the gases trapped to be compressed in these vents without retarding the flow of metal.

Ordinarily on these type dies, billets are heated to a temperature of 2100 F, and it is essential that the temperature be the same for all dies typed in any one master. A very important factor in typing dies is the control of the atmosphere in the heating furnace and the protection of billets when heating. Since the dies require no machining, scaling cannot be permitted.

Forging trim dies can be also typed. The openings in these dies are typed so accurately that the only work necessary to finish them is a few strokes with the file to accommodate the wear in the forging dies, and to shape the bottoms.

Some idea of the savings effected by the die-typing method can be gained from the Ford production records. For instance, one crew of two men can type 80 die inserts for connecting-rod forging dies (40 sets, in 8 hr), whereas it is estimated that from 26 to 30 hr are required to sink one set of rod dies by the conventional method. A certain set of the trim dies required 15 hr by the old method, and only 18 min by the new. A ball seat punch die took 15 hr by the old method, and 15 min by the new.

It is said that the productive life of typed dies is about 25 per cent longer than that of cut dies on forging and upset work, and equal to that of cut dies on trimming work. The types used to form the dies are themselves made by the same typing process. (*The Iron Age*, vol. 129, no. 11, March 17, 1932, pp. 660–661, 1 fig., *d*)

TESTING AND MEASUREMENTS

Radium in Engineering Inspection

THIS article deals chiefly with gamma radiation work and compares radium photography with X-rays. The former is more penetrating than X-rays, but fine details such as fine cracks and small inclusions are not detectable by radium to anything like the same extent as they are by X-rays. Contrast is very much less in a radium photograph than in one by X-rays. Where the specimen to be examined is irregular in shape and of varying thickness, X-ray examination is difficult and a number of exposures have to be made using a lead cover to stop fogging. Owing to the much lower absorption coefficient for gamma rays, a radium picture of such objects may be taken of the whole structure at one exposure and the radiograph will not be appreciably fogged. It will show flaws equally well in thick and thin sections. Another great advantage of radium is its portability. A brief discussion of the technique is followed by a statement of methods to be used in protecting the health of the operator. Typical radiographs are given in the original article.

The author believes that neither X-rays nor radium offers a practical proposition for routine testing. They both have their chief value as a consultative method, except in those instances where the importance of the structure demands absolute freedom from flaws and consequently justifies the most stringent inspection at any cost. X-rays, particularly now that practical equipments are available, do supply a reliable method of test for a number of metal structures and many varieties of welding. They do yield practical information concerning most of the flaws, and by the employment of appropriate technique a very sound idea of the dimensions of such flaws may be obtained. Thus expensive work on unsound material may be stopped, and, on the other hand, expensive castings and forgings may be saved from injudicious rejection.

Radium has an equally valuable function. It may be used to detect big cracks, blowholes, and corrosion cavities in large structures. By reason of its penetrability it may often be used to examine a structure *in situ*, such as a casting that is actually built into a ship. By a further refinement of technique by which radon (radium gas) will be employed, it is probable that comparatively fine detail may be achieved. This, too, will owe its maximum value essentially to the portability of radium, which obviously may be insinuated into places impossible of access by an X-ray tube. (V. E. Pullin, Director of Radiological Research, Research Department, Woolwich, in *The Engineer*, vol. 153, no. 3982, May 6, 1932, pp. 492–494, 6 figs., *p*)

Rivet Testing

AT THE present time when so much discussion is being raised as to the relative merits of riveted and welded connections, not only for steel structural work but also in boilermaking, it seems appropriate that the National Boiler and General Insurance Company, Ltd., of Manchester, should have brought out an instrument especially designed for the investigation of the interior condition of rivet holes which may be suspected of being the source of failure on account of an incipient crack

It is not, of course, uncommon to have a rivet punched out on account of some doubt as to the soundness of the joint, but to study the surface of the hole is not an easy matter, especially when the plates are thick. The instrument of the insurance company seems to meet the requirements. It is virtually an inverted periscope with an enlarging lens, and is illustrated in Fig. 9.

The instrument is contained in a tube small enough to be inserted in a hole 7/8 in. in diameter, enabling a complete examination to be made of the entire plate surface from which the rivet has been withdrawn. As the surface under examination is both strongly illuminated by an electric lamp and magnified seven times, even the most minute crack is visible after suitable preparation of the hole, while the field of view being 3/8 in. in diameter, the search for fractures can be comparatively rapid.

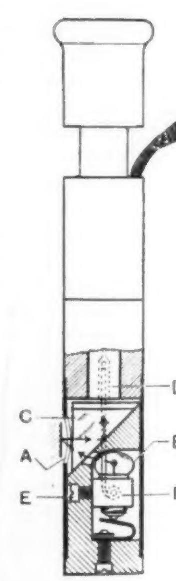


FIG. 9 INSTRUMENT FOR THE INVESTIGATION OF THE INTERIOR CONDITION OF RIVET HOLES

Referring to Fig. 9, the lamp *B* and the prism *C* can be withdrawn as a unit from the end, the electrical connections being automatically made by pins and sockets, shown at *D*; these pins also hold the unit in place and register its position.

By means of the screws *E* and *F* the lamp holder can be removed and the bulb changed. A bulb of the "spot light" type is recommended. As fractures in the plate may be very fine, it is advisable to prepare the surface of the rivet hole as follows: After the withdrawal of the rivet, the surface of the hole should be filed smooth and polished with emery cloth. The surface should then be etched with nitric acid of about 1.2 specific gravity for a period of about five minutes, and washed with water or a solution of soda to neutralize the acid. In case there is any doubt as to whether a mark is a crack or not, it will be necessary to carry out further polishing and etching. (*The Engineer*, vol. 153, no. 3982, May 6, 1932, p. 509, *d*)

THERMODYNAMICS

A Comparison of Recent Steam Tables

THIS comparison covers the values of the International Skeleton Table of 1930, the Keenan tables of 1930, Callendar's tables of 1929, and the German tables (Knoblauch, Raisch, Hausen, and Koch) of 1932.

TABLE 1 COMPARISON OF RECENT TABLES FOR SATURATED STEAM

I — International mean value — 1930.
Ke — Keenan tables, interpolated — 1930.
C — Callendar tables, interpolated — 1929.
Kn — Knoblauch, Raisch, Hausen & Koch — 1932.

Temp. F.		Abs. Press. Lb. per Sq. In.	Int. Toler. ±	Total Enthalpy, Mean B.t.u. per Pound: Sat. Liquid (h_f)	Int. Toler. ±	Evap. (h_{fg})	Sat. Vapor (h_g)	Int. Toler. ±
392 (200)	I	225.6	0.14	366.2	0.18	833.9	1200.1	4.5
	Ke	225.5		366.3		833.0	1199.3	
	C	227.4		366.5		838.4	1204.9	
	Kn	225.5		366.2		833.2	1199.4	
482 (250)	I	557.5	1.42	466.4	0.90	737.3	1203.7	7.2
	Ke	577.1		467.4		735.2	1202.6	
	C	582.1		467.5		744.7	1212.2	
	Kn	576.7		466.4		734.7	1201.1	
527 (275)	I	863.3	1.42	520.0	1.8	678.3	1198.3	9.0
	Ke	863.2		523.1		671.5	1194.6	
	C	868.5		522.0		685.3	1207.3	
	Kn	862.3		519.8		674.4	1194.2	
572 (300)	I	1247.4	1.42	579.4	3.6	602.7	1182.1	9.0
	Ke	1247.2		583.2		596.1	1179.3	
	C	1249.0		580.3		613.7	1194.0	
	Kn	1246.4		577.9		601.9	1179.8	
617 (325)	I	1749.4	1.42	647.7	5.4	509.2	1156.9	10.8
	Ke	1750.6		648.7		506.0	1154.7	
	C	1744.1		645.3		522.3	1167.6	
	Kn	1749.4		644.1		509.2	1153.3	
662* (350)	I	2399.4	2.13	726.9	9.0	379.7	1106.6	14.4
	Ke	2401.3		729.6		376.0	1105.6	
	C	2384.0		724.0		392.7	1116.7	
	Kn	2398.6		723.3		376.1	1099.4	
700	Ke	3096.4	....	846.3	....	156.9	1003.2	....
	C	3099.0		833.5		188.7	1022.2	
698	Kn	3050.4	....	824.1	....	181.7	1005.8	....
705.4	Ke.-1931	3211.6	....	924.8	....	0	924.8	....
706.1	Ke.-1930	3226.0	....	925.0	....	0	925.0	....
	C	3246.3		875.8		116.1	991.9	
705.2	Kn	3201.0	....	915.8	....	0	915.8	....
710	C	3350.0	....	883.2	....	84.3	967.5	....
717	C	3650.0	....	846.0	....	0	846.0	....

* Upper limit of 1930 International tables.
Temperatures in parentheses are in degrees centigrade.

The original article contains a series of curves giving a comparison of Keenan, Callendar, and Knoblauch values for enthalpy in the region of the critical point, as well as a table presenting a comparison of recent values for saturated steam in English units. This table is reproduced by special permission of *Power*. A second table, not reproduced here, gives a similar comparison of recent tables for superheated steam (mean Btu per lb). From the comparison in the accompanying table it would appear that Callendar's values for saturated steam are above those of the International Table, while those of Keenan and Knoblauch tend to be lower, and only the Knoblauch values are within the International tolerances over the entire range. The disagreement becomes greater above 662 F, the limit of the International Table for saturated steam. As regards superheated steam, Keenan and Knoblauch are both in fairly close agreement with the International Table, Keenan's values being somewhat high for the higher temperatures. In general, the agreement for superheated steam is better than for saturated steam. As regards pressure-enthalpy relationships for the higher pressures and temperatures, at 850 F there is quite close agreement up to a pressure of about 2800 lb per sq in. Beyond that point the Callendar data show a more rapid decrease of enthalpy with increase in pressure. At 700 F Keenan and Callendar agree up to about 2500 lb per sq in., but Keenan's isotherm then becomes higher than Callendar's. The Knoblauch 700-deg isotherm is considerably above those of both Keenan and Callendar, up to about 2800 lb, but then falls at a more rapid rate than either of the other two.

The critical point is usually considered as that pressure and temperature at which the meniscus disappears when a liquid is confined in a transparent tube and heated. Callendar found this phenomenon to occur at about the same temperature and pressure as is shown by the critical points of Keenan and Knoblauch, but claimed to be able to detect a difference in density of the liquid and vapor above that point on up to the critical point which he indicates. He later made direct calorimetric measurements of enthalpy in this region which, he claimed, verified his first observations. (P. A. Willis, G. A. Hawkins, and A. A. Potter, of Purdue University, in *Power*, vol. 75, no. 23, June 7, 1932, pp. 841–843, 1 fig., *cA*)

TRANSPORTATION (See Fuels and Firing: Pipe-Line Transportation of Pulverized Coal)

VARIA

The Lake Balkhash Copper Works

A COPPER-mining and smelting plant with an annual capacity of 175,000 metric tons of copper is to be built in eastern Kazakistan in northern Siberia. The construction difficulties to be overcome are very great. The nearest railroad station is about one hundred miles, but a short line is being built from the Trans-Siberian Railroad to the lake. The country surrounding the lake is entirely barren and the climate runs to extremes. In winter the thickness of the ice is often as much as 7 ft, while in summer the heat is so great that eggs can be cooked in the hot sun. All building materials have to be shipped in. The selection of the location is due, first, to the presence of copper ore about 15 miles north of the lake. The resources are estimated at 1,600,000 tons of metallic copper, but at Karaganda, not far away, are to be found coal deposits estimated to contain 15,000,000,000 tons. These will be available for the use of the copper plant, railroad, etc. A town to contain a population of 30,000 is to be completed this year, and nurseries are being organized to provide trees for planting around the site of the plant and in the city to be built. (*Economic Review of the Soviet Union*, vol. 7, no. 10, May 15, 1932, pp. 229–231, 2 figs., *g*)

World Beaters—What's Stopping Them?

AN ENGINEER tells why, as he sees it, progress in product development is slow, and how it is often throttled, or how it is promoted. In railroad equipment progress is ham-

pered by American Railway Association standards, the Interstate Commerce Commission, the rules of interchange, and tradition. On the other hand, he tells the story of the tank cars made from rolled aluminum plates. The Aluminum Company of America several years ago developed such plates of a size large enough for railroad-car tanks and built a sample car jointly with the General American Tank Corporation, although it was believed that the number required was limited and that these cars would be used practically only for hauling acetic acid. The car proved successful and also turned out to be just the thing for hauling formaldehyde and iron-free caustic soda. Over one hundred such cars have been built to date. As examples of resistance to new ideas are mentioned the difficulties in introducing centerless grinders and air conditioning in homes. (*Product Engineering*, vol. 2, no. 11, pp. 501–503, illus., *g*)

WELDING

Nitrogen in Arc Welds

A PAPER on this subject under the title, "The Influence of More Common Elements in Inhibiting Needles in Nitrogen-Rich Steels and Arc Welds," was presented before The Iron and Steel Institute at its meeting, May 5–6, 1932, in London. At about the same time a report on welds was published by the British Engine, Boiler, and Electrical Insurance Co., Ltd. As the original paper is not yet available, only some of the discussion can be abstracted here.

Dr. Ing. A. Fry said the German technical authorities had for a long time opposed the introduction of welding into boiler practice on the ground that welding was not reliable enough, and to a certain extent he felt they were right. A fortnight previously he had had the opportunity of listening to a lecture at the Technical High School in Berlin by Director Potts, who had studied the influence of nitrogen in the weld and also the effects when nitrogen was kept out of the weld. Nitrogen was kept out by use of a special kind of covered electrode, and it was found that those welds which contained a large amount of nitrogen were in all cases improved by annealing. With electrical welding, on the other hand, which contained nitrogen, the welds were worse after annealing.

A. T. Roberts said the impression had been gained that nitrogen was a harmful property in welding, but that was not so. In most commercial steel welds carbon and manganese were both below 0.1 per cent, or 0.1 per cent as a maximum, and in some tensile tests which he had made recently a figure of 30 tons was obtained in one case with 28 per cent elongation, while in another the figure was 27 tons tensile and 27 per cent elongation. In the first case the manganese was 0.33 and the carbon 0.09, while in the other the manganese and carbon were both 0.1 maximum. It would have been impossible to obtain these figures had there not been some hardening element present having an effect similar to that of carbon. Work had been done showing that nitrogen had an effect on steel similar to that of carbon, but to a much greater degree weight for weight. The chief aim in the deposition of weld metal should not be to exclude nitrogen entirely, but to regulate the amount.

D. Sillars stated that his own experience with many tests was that, whether dealing with covered or uncovered electrodes, the weld was worse after normalizing than before. The author is his reply to the discussion said that the question of whether nitrogen in weld metal was harmful or not depended on the degree to which it was present. Oxygen in weld metal was more harmful than nitrogen.

As regards the effect of annealing, the author's experience had been that the annealing of welds very often brought down the shock value, but in other cases when a very good braunite normal annealing was used, the shock value had actually gone up. (L. W. Schuster in a paper abstracted through *The Engineer*, vol. 153, no. 3983, May 13, 1932, p. 522, *p*)

The Twin-Spot-Welding Process

THE capacity of an ordinary resistance spot-welding machine is limited by the fact that extension of the electrode arms, such as would be required with large work, in welding sheet-metal covers on wide surfaces, or for attaching thin parts to thick, would mean an increase in resistance in the secondary circuit, with resultant increased current consumption for each weld. It is claimed that these limitations are eliminated by the new process of "twin spot" welding, where the electrodes are not placed opposite each other as before, but side by side so that two spots are simultaneously welded by both electrodes being pressed upon the part to be welded.

Conventional spot welding cannot be applied where the under part is heavy and inaccessible from the rear. It can be done with the new process. The sequence of events in twin-spot welding, say, a sheet-metal part to a heavy base, is as follows:

Upon bringing the double electrode in place, the circuit is closed by the upper piece. At the same moment, heating and softening of the metal under the two electrodes takes place, and this, in combination with the pressure applied, causes intimate contact with the base. Owing to the increase of the electric resistance of the heated portions in the thin upper part, the current, following the line of least resistance, now flows through the lower part, causing momentary heating of the contact areas in the latter, and welding takes place. By reason of this action, the one-sided welding effected in the twin-spot process offers the designer full freedom in the choice of the parts to be connected.

A particular advantage of the new process is that sheets coated with rust and scale, and even painted with red lead, weld as well and as quickly as sheets that have been previously cleaned. According to the specifications of the German Railroad Company, for instance, steel structures must be well coated with red lead on surfaces that are in contact. The usual method of spot welding fails on such parts, even where it is possible to get at them with the electrodes from either side without difficulty, simply because the circuit cannot be established owing to the insulating layer of red lead. In twin-spot welding, matters are entirely different, since the circuit is closed at once through the upper sheet of metal alone. The spots beneath the electrodes are thus heated up, causing the red lead to burn from underneath the electrodes, and welding then takes place as if there had been no coating. The coat of paint remains uninjured within a range of about twice the spot-weld diameter. Since the parts are always pressed together in welding, the surrounding paint is stuck together, thereby hermetically sealing the spot and ideally protecting it from rust.

The twin-spot welder comprises a transformer to which the double-electrode welding head is connected by short flexible cables. In the model now on the market the electrodes are pressed in place by hand. (K. Ruppin in *Engineering Progress*, vol. 13, no. 2, Feb., 1932, pp. 38–39, 3 figs., *d*)

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer.

SYNOPSES OF A.S.M.E. PAPERS

THE papers, abstracted on this and following pages appear in the current issues of Aeronautical Engineering, and the Fuels and Steam Power, Hydraulics, Iron and Steel, Management, Materials Handling, and Petroleum Mechanical Engineering sections of A.S.M.E. Transactions, or are available on request in mimeographed form. These sections have been sent to all who registered in the similarly named Divisions. Other sections are in the course of preparation and will be announced, when completed, in later issues of "Mechanical Engineering." Copies of the Transactions papers may be obtained by those not registered in these Divisions by addressing the Secretary of the A.S.M.E., 29 West 39th Street, New York, N. Y.

AERONAUTICAL ENGINEERING

Study on Airplane Weight Complex

BY DECIDING on the type of engine and the overall dimensions of an airplane, the weight becomes quite well fixed. To obtain good take-off and climb characteristics the gross weight per horsepower should be kept low. Such items as engines, starters, propellers, generators, wheels, tires, and instruments have a weight which cannot be altered by the airplane designer, so his problem is quite difficult. In this paper the author groups the various equipment and parts of an airplane into three classes: (1) Those with weights outside the designer's direct influence, (2) those with weights over which the designer has limited influence, and (3) those with weights which can be controlled by the designer. Design data on these weights and percentages of weight empty are also given for three entirely different types of Fokker airplanes. These are the Super-Universal, the F-10-A, and the F-32. (Paper No. AER-54-7, by A. A. Gassner.)

Altitude-Laboratory Tests of Aircraft Engines

THIS paper gives a concise description of the altitude laboratory and its operation, followed by a discussion of available reports on altitude-laboratory testing at the Bureau of Standards during the past 13 years and a summary of conclusions drawn as to engine performance under altitude conditions. Experimental data are presented on a modern 12-cylinder aircraft engine to illustrate (1) the effect of pressure and temperature on power, and (2) some theoretical and practical advantages from supercharging. Additional problems to be studied with the present equipment and the need of an altitude laboratory for testing air-cooled aircraft engines are mentioned. Approximate altitude-performance data on engines of the latter type are already being obtained by the Navy Department. An extensive bibliography is included. (Paper No. AER-54-8, by H. K. Cummings and E. A. Garlock.)

Sonic Altimeter for Aircraft

THE author describes the development of an aircraft altimeter which works on the sound-echo principle now commonly employed for depth finding at sea. The problem was to devise means and equipment to send a powerful sound from the airplane and receive the echo back from the ground through the intense masking sounds produced by the engine and propeller. It is believed that the use of the sonic altimeter and sonic boundary markers will make fog flying reasonably safe. (Paper No. AER-54-9, by Chester W. Rice.)

Aeronautical Research in Canada

IN A COUNTRY where rail transportation to much of the territory is impracticable, aerial transportation, with its greater flexibility, is destined to render most useful service, particularly of the seaplane and flying-boat types. The problems peculiar to Canada have created a growing need for research facilities capable of dealing with them. Some of the most modern aeronautical research equipment is being completed at Ottawa, and work is in progress. (Mimeographed paper, by J. J. Green, G. J. Klein, and K. F. Tupper.)

Performance of Aneroid Altimeters for Landing and for Level Flying

THE aneroid altimeter, most generally used for indicating altitude of aircraft, can also be used to maintain level flight at a chosen altitude and to determine the altitude above a flying field, provided corrections are applied for the various errors. The sources of error encountered in using the altimeter for these purposes are considered in the paper, including instrumental errors and those inherent in the barometric method. Data on the performance of the best-quality instruments now available commercially are given. (Mimeographed paper, by W. G. Brombacher.)

Fuel Systems in Aircraft

FUEL systems generally used in aircraft are described and suggestions are made as to the causes of accidents occurring during take-off or in a climb, with forced landing. Engine stoppage or partial failure caused by a crude and inefficient fuel-supply system is traced. The gravity-feed system and the engine-driven fuel pump are compared. Engineers are urged to make a more thorough study of fuel-system design and action under all conditions of flight so that the engine shall not stop at a critical moment. (Mimeographed paper, by E. Curran.)

Vocational Training in Aviation

TRAINING programs for airplane mechanics and aircraft-engine mechanics in public and private schools, with information as to their present status, are covered, together with some discussion of the standards that should be considered with reference to the further growth, improvement, and development of these programs. A policy of up-grading those already in the industry through suitable trade-extension courses will give greater assurance of benefit to the industry than any policy of encouraging ambitious men and boys to prepare for jobs which at present do not exist. (Mimeographed paper, by Frank Cushman.)

FUELS AND STEAM POWER

Heat Transfer From Condensing Steam to Flowing Water

THE method developed in this paper correlates in part some of the known experimental data for heat transfer through the single tubes at low rates of heat flow with the experiments made by Geo. A. Orrok in 1910. This method may be used at low rates of heat transfer such as occur in condensers to establish an ideal with which to compare the actual performance. Such a comparison indicates how close the performance of the actual condenser approaches the rate of heat transfer which can be secured with a single tube completely surrounded by air-free steam. The formula for the heat transfer through the film on the water side of the tube is taken from a paper presented by Edwin R. Cox at the 1927 Annual Meeting of the A.S.M.E., and this formula is a development of data prepared by Chester W. Rice. The method given in this paper should prove useful in calculating changes in the rate of heat transfer caused by altering the velocity of the water in the tubes in an actual condenser, with the inlet water at the ordinary temperatures, say, above 50 F. (Paper No. FSP-54-8, by A. T. Brown.)

Development of Pulverized-Coal Firing and Study of Combustion

THIS paper reviews briefly the development of burning pulverized coal under steam boilers. It points out the difficulties experienced in the early installations, and how some of these difficulties were overcome by changes in the design of furnaces and burners and also by the adoption of more advantageous methods of firing. It discusses the present practice in rates of combustion in furnaces of various designs, and the factors that set the limitations. A large part of the paper is devoted to a detailed study of combustion of pulverized coal. (Paper No. FSP-54-9, by Henry Kreisinger.)

Improvements in Missouri-Kansas Coals and Their Burning Equipment

IN THE producing of Missouri-Kansas steam coals there have always been certain undesirable qualities, the reduction of which would materially improve the quality of the coal: namely, high ash, high sulphur, low fusion temperature, excessive moisture, and inconsistent quality. While these undesirable qualities exist in most coals, the character of the local coals and the mining method employed (mostly strip pitting) make them more evident in these fields. The effort put forth in recent years to improve the quality, and the results obtained, are briefly covered in this paper. During the past 25 years improvements have been made to solve various operating problems and to increase boiler-room efficiency. The major improvements made in this field and the actual results obtained are also covered. (Paper No. FSP-54-10, by E. L. McDonald.)

Comparative Performance of a Large Boiler Using Oil and Natural-Gas Fuels

TESTS were made with utmost care by well-trained and experienced observers, and the data presented are comparable in accuracy with carefully conducted tests burning coal. The boiler tested was a Babcock & Wilcox cross-drum, straight-tube type with interdeck superheater. The furnace was completely inclosed by Bailey-type water-cooled walls. The Babcock & Wilcox air heater was of tubular construction. Peabody combination oil and gas burners were used. The highest rate of output at which the boiler was tested was 450,751 lb of steam per hour, which represented operation of the 3416-hp boiler at 413.2 per cent of rating. Efficiency-capacity characteristics are straight lines between 100 per cent and 400 per cent of rating. Efficiency with oil fuel is approximately 4 per cent higher than with gas due to higher "hydrogen losses" with gas fuel. Superheated-steam temperatures are considerably higher when burning gas than when burning oil fuel, due jointly to lower water-wall heat absorption and larger flue-gas volume while burning gas fuel. The maximum heat liberation was 27,300 Btu per cu ft of furnace volume, although it is felt that heat-liberation rates as high as 60,000 Btu per cu ft might be satisfactorily maintained in this furnace. (Paper No. FSP-54-11, by F. G. Philo.)

HYDRAULICS

Piezometer Investigation

THIS investigation had for its object the determination of a standard piezometer for commercial use and the study of the hydraulic effect of various conditions of operation upon different forms of piezometers. Piezometers were compared in operation with suitable reference orifices, the differentials being measured with hook gages. A number of factors concerning the performance of piezometer orifices were analyzed. The paper gives results covering a variety of forms and conditions, and should assist in establishing a standard form of piezometer. (Paper No. HYD-54-1, by Charles M. Allen and Leslie J. Hooper.)

Hydraulic Butterfly Valves

THIS paper describes some of the special features of design found in the modern butterfly valve and which have been adopted within recent years, during which this type of equipment has been developed to meet some of the unusual requirements existing in many modern hydroelectric projects. Means for making this type of valve more effective in limiting leakage are discussed in some detail, and attention is given to general considerations affecting the design of disks and bodies. Some interesting types of operating mechanisms are outlined, and various kinds of protective and auxiliary equipment are described. Recent applications of butterfly valves for free-discharge service have broadened their useful field, and the suggestion is made that valves of this type might well find future use for other purposes than those existing in the hydraulic-power industry. (Paper No. HYD-54-2, by Ross L. Mahon.)

Research Institute for Hydraulic Engineering and Water Power

THIS paper presents an extended and copiously illustrated description of the latest project of the Kaiser Wilhelm Society for the Promotion of Science at Obernach, near Munich, namely, the world's largest open-air hydraulic experiment station. The Institute was planned to serve the twofold purpose of the supervision of a permanent outdoor laboratory with equipment to carry on large-scale and full-scale model experiments and the training of a staff of engineers who could conduct investigations in various parts of the country at the actual sites in question. The organization, purposes, and methods of the society are set forth at length, and particulars are given of the initial major experiments carried out at the sta-

tion, and of the procedure employed and the methods of computation. (Paper No. HYD-54-3, by Hunter Rouse.)

IRON AND STEEL

Lignum-Vitae Bearings for Roll Necks of Medium-Sized Rolling Mills

THE performance of metal roll-neck bearings is frequently unsatisfactory, particularly with regard to rapidity of wear and excessive power loss in friction. Roller bearings, although free from these disadvantages, are comparatively expensive, and are limited in applicability because of their space requirements. These circumstances provide a definite field of usefulness for bearings made of very hard wood. Tests of various species of lignum-vitae and of different methods of cutting bearings from the log have indicated specifications under which satisfactory lignum-vitae bearings can be produced. Bearings produced according to these specifications are used successfully in a great many rolling mills and can be lubricated adequately by means of water sprays. With such lubrication, the rate of wear and the power loss in friction are considerably lower than those of metal bearings lubricated with oil or grease. In some rolling mills the use of this type of bearing has effected power savings as high as 23 per cent in comparison with metal bearings. Tests have also shown that their life in certain cases is 15 times as long as that of metal bearings. Experience has indicated that the best results with such bearings can be obtained by polishing the roll necks before installation in the mill. (Paper No. IS-54-1, by K. W. Atwater.)

Water-Lubricated Soft-Rubber Bearings

RUBBER bearings lubricated with water are found to have remarkably low coefficients of friction and to give excellent service under many conditions. The softness of the rubber makes these bearings stand up in the presence of sand and grit, and it also makes the laws of lubrication governing them differ from the classical laws worked out by Reynolds and others for cylindrical metal bearings.

This paper gives a comparison of the friction of rubber and metal bearings lubricated with water at various loads and speeds. Metal bearings have the lower static coefficient of friction, but the coefficient of running friction is usually lower for rubber bearings. The difference in favor of rubber bearings increases as the load increases, provided the shaft is smooth and the load is applied after the shaft gets up to speed. Rubber bearings have been tested at loads up to 850 lb per sq in.

Rubber bearings are particularly suitable for use on shafts running at high speeds, not only because the friction is very low but because the softness of the rubber allows the shaft to turn on its center of gyration, even though this differs slightly from the geometrical center, thus reducing the dynamic load on the bearing and the vibration in the machine. (Paper No. IS-54-2, by W. F. Busse and W. H. Denton.)

Straight Copper-Lead Alloys Versus Leaded Solid-Solution Bronzes for Heavy-Duty Bearings

THIS paper describes the metallurgical investigation of various bronze bearing metals and deals with a comparative study of the bearing performance of those metals. The technological possibilities of producing heavy-duty bearings were investigated, and it is stated that experimental installations of bearings with severe requirements are under trial. (Paper No. IS-54-3, by F. R. Hensel and L. M. Tichvinsky.)

Application of Impregnated-Fabric Bearings to Roll Necks

THE suitability of celoron for roll-neck bearings has led to widespread use of the product in that field. Its resilience allows bearings to absorb severe impact loads without permanent deformation. Celoron bearings are most commonly lubricated with water, in which case the rate of wear and the power consumed in friction are much less than those of metal bearings. The application of a superior lubricant such as oil or grease improves their performance appreciably. Celoron bearings serve most efficiently on highly polished roll necks, have produced substantial power savings in comparison with metal bearings, and their life in numerous installations has been found to be many times that of metal bearings. (Paper No. IS-54-4, by Arthur J. Schmidt.)

Application of Tapered Roller Bearings in Merchant-Bar Mills

TAPERED roller bearings have played an important part in the numerous developments in the art of rolling metals. Their use has made possible a considerable decrease in the consumption of power by the elimination of friction, a considerable decrease in the cost of the electrical equipment required, a decrease in the cost of lubrication and general maintenance, an increase in the speeds of operation and consequently the tonnage produced, and a marked increase in the accuracy of the product. In this paper the actual experience, over a period of five years, in the proper design, mounting, and operation of bearings in merchant-bar mills is discussed. Extracts are given from the results of a series of power tests made on the same mills alternately equipped with plain and tapered roller bearings. Various means of lubrication of rolling mills, pinion stands, and gear drives are cited. The design of suitable bearing closures is also taken up and shown in detail. The illustrations included are of equipment in actual operation in various mills. (Paper No. IS-54-5, by S. M. Weckstein.)

MANAGEMENT

Production Management Applied to the Drafting Department

THIS paper aims to bring out some of the more important factors in the management of the drafting department of one corporation. The output of this drafting department was in excess of 10,000 drawings in 1928 and 12,000 in 1929, varying in size from 1 to 10 sq ft. There are three divisions, known as the boiler, stoker, and pulverized-fuel divisions. Each is divided into squads working on specific types of equipment. The management plans for a straight-line curve by moving experienced men from one division to another so that each division will carry a full allotment of work. The essence of the production is the speedy accomplishment of the work on the lowest cost basis, and the unification of all interests in any specific feature of design. (Paper No. MAN-54-1, by William J. Kunz.)

Improving Drafting Management

A SYSTEM of improvement in drafting management extending over four years of experience is described, the use of these methods having cut drafting costs in half, while

average salary rates have been increased, design quality has been improved, and drafting accuracy has been maintained. A feature of the plan is that each draftsman checks his own work, this resulting in increased responsibility and improved accuracy. Record charts showing the results attained are given. (Paper No. MAN-54-2, by F. D. Newbury.)

Variations in Maintenance Costs and Procedure

THIS paper treats in a new way the important function of maintenance in industry. It is an analysis of the ratio of the maintenance forces in 20 industrial plants. The authors give reasons for the discrepancies shown by the analysis. The paper should be of assistance to managers wishing to conduct their maintenance activities economically. The charts indicate by the wide dispersion of ratios that there is a large field for improvement in the general treatment of the maintenance problem. (Paper No. MAN-54-3, by E. V. Stoody and G. I. Ross.)

Waste Elimination

THIS is a symposium of four papers, respectively entitled: Savings by Substitution of Other Materials; Weekly Accounting of Waste in the Johns-Manville Corporation; Maintaining Interest in Suggestion Systems; and Common Savings in Shop Waste. These papers give methods of cutting manufacturing cost by substitution of recovered metals in place of virgin metals, and the distribution of waste through channels that will bring it again to the refining furnace and the raw-material field; discuss the controlling of waste in one plant, so that reports cover what waste has been produced, how it is measured, and where to look for trouble and how to correct it; the value of creative ideas supplied by the man on the job, with methods for developing new ideas and applying old ones; and the value of a proper scrap-handling system on a great railroad so that all scrapped equipment and materials are cheaply and quickly collected and sorted and then disposed of to best advantage. (Mimeographed papers, by (respectively) George Bangs, S. K. Cooper, Prof. W. E. Fisher, and C. B. Hall.)

MATERIALS HANDLING

Preventive Maintenance of Materials-Handling Equipment in Foundries

HANDLING equipment has become essential in foundries, and the severe operating conditions make its maintenance a specialized task. Adequate maintenance at minimum cost may be attained by effectively protecting the handling equipment against severe conditions and against normal deterioration and wear. A periodic inspection and preventive service and the design of equipment to withstand rigorous conditions are chief factors. (Mimeographed paper, by T. A. Bissell.)

PETROLEUM MECHANICAL ENGINEERING

Lubricant Testing

A SIMPLE machine is described which was developed for the purpose of testing the power of lubricants to withstand high unit pressures with high rubbing speeds. The results of these tests are shown in photos of test blocks indicating the effect of pressure and speed when using oils of varying viscosities and varying composition. The authors advocate the development of standard apparatus for determining the capacity of lubricants to be used for gearing in general and particularly for high unit loading. The effect of rubbing speed and surface temperature should be taken into consideration, and also the quantity of oil flowing over the loaded members during the test. (Paper No. PME-54-1, by E. G. Boden and O. L. Maag.)

Welding Progress at the A. O. Smith Plant

THIS paper covers the history of welding of pressure vessels in one plant over a period of one-third of a century. The oil industry is credited with having provided the opportunity for the rapid development of welding, not being limited by code restrictions as to the size and shape of desired pressure equipment. Testing equipment is described, and tests on steel for pressure vessels are detailed. (Paper No. PME-54-2, by T. McLean Jasper.)

New Development of Chromium-Tungsten Steel for Oil-Refining Service

APPARATUS used in oil-refining service has been designed mostly from practical experience instead of experimental research, and the experience gained from operation over long periods gives notable results, among them being the fact that certain alloys are resistant to corrosive conditions, and that if these alloys are used the so-called limiting creep stresses can be more than double what they are for carbon steel. Other factors besides the strength of metals and corrosion resistance that must be considered are thermal expansion, thermal conductivity, resistance to abrasion, scaling, and oxidation. The search for an alloy steel that would resist the severe service in oil refining resulted in the development of chromium-tungsten steel. A series of tests are described in the development of properties required of a steel for high-temperature construction and service. (Paper No. PME-54-3, by V. T. Malcolm.)

Evolution of Pressure Vessels to Meet Present-Day Refining Pressures and Temperatures

IN THE growth of the oil-refining process to meet the demand for fuels for internal-combustion engines, the pressure vessel has played a foremost part. The paper covers the progress of riveting and welding in perfecting a tight and dependable container. Failures attributed to defective plate and to defective welding led to greater experience and operating knowledge. Recognizing the future tendency toward still higher temperatures and pressures, research was devoted to developing a new method of electric welding and the rolling of smooth seamless cylinders of large diameter with which to fabricate vessels of any commercial requirement. (Paper No. PME-54-4, by H. LeRoy Whitney.)

Suggested Specifications for Testing Tubular Heat-Transfer Equipment for Oil Refineries

THIS is a draft of specifications for testing tubular heat-transfer equipment after it has been installed in the refinery, and which shall serve as the basis for a more complete and general specification to apply to any equipment of this character which may be used by the refiner in oil processing. Points are enumerated that must be considered by the designer, and some mechanical details are listed which the purchaser's inspection must assure as being right, to avoid difficulties due to leakage of equipment, cleaning, and replacements in service. (Paper No. PME-54-5, by Walter Samans.)

Correspondence

CONTRIBUTIONS to the Correspondence Department of "Mechanical Engineering" are solicited. Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

Markings on Bullets and Shells Fired From Small Arms

TO THE EDITOR:

As the writer has made the study of markings on bullets and shells after recovery from being fired from a rifle, pistol, or revolver a hobby for over thirty years, and believes that he was probably the first one in the United States to write for publication on this interesting subject, he wishes to comment on the articles "Markings on Bullets and Shells Fired From Small Arms," by Prof. Charles O. Gunther, published in the February (pp. 107–113) and December (pp. 1065–1069), 1930, issues of MECHANICAL ENGINEERING.

When one reads the articles as written, if some of the statements are to be taken at their face value, one is not surprised at the interrogatory beginning of the second paragraph, nor at the qualifying clause: "If it is possible to establish the identity of the weapon, etc.," for instead of making the subject clear to the casual reader, the author leaves it in the doubt he raises in his opening sentence.

The description of the supposed action of the rifling lands on the bullet as illustrated in Figs. 6 and 7 of the February issue is incorrect in its reasoning. Instead of the land *abcd* coming in contact with the bullet jacket at *nm* as shown, it must come in contact at *kh;* for the bullet, when it strikes the land, has but little velocity and energy compared to what it has later on, and therefore the translation from a straight-line to a revolving movement would be more easily accomplished than at a time when the bullet has gained greater momentum. According to Professor Gunther, the lands scrape from the bullet jacket a section of metal at least 0.002575 in. deep and approximately 0.036 in. wide and of a considerable length by a revolving motion of the bullet, before the motion is translated from straight-line to revolving movement, which is an impossibility. The jacket metal is cupro-nickel, of a hardness comparable to that of soft steel. It is a tough, tenacious metal, which qualities would preclude any such direct shearing action. In military-rifle ammunition this jacket is made of gilding metal, but not, it is believed, in .45 auto-loading-pistol ammunition. However, the Western Cartridge Company uses a metal called "Lubuloy" for the jackets of these bullets.

On page 110 (February issue) Professor Gunther refers to the muzzle velocity and gives it as 802 fps. This is the velocity taken by a chronograph at a distance of 25 ft from the muzzle. The maximum velocity is attained not at the muzzle but at a distance of 8 ft therefrom.

In the third paragraph on page 111 the author states that: "The circumferential scratches near the muzzle on the surface of the two lower lands, etc.," and would have it inferred from the preceding paragraph that they were made by the drilling and reaming operations. These markings were caused by the abrasion of chips that entered the bore when the muzzle was being faced off and given its rounded contour. They have no bearing on the subject, for they cannot be transmitted to the surface of the bullet.

Referring to page 112, fifth and sixth paragraphs, the forming of the bullet jacket is not a drawing operation entirely. The first operations are of a drawing nature, but several of the latter ones are swaging operations that would tend to nullify any markings made during drawing. The marks shown in Fig. 11 are those made by the barrel, excepting some few that may show on the engraved (sunken) portion. This portion was made by the rifling lands, and as all tool marks on the land are of a circumferential nature, being made by reamers, they would not be engraved on the bullet. The striations referred to on the ogive of the bullet are those made by the loading tool and not in the process of manufacture.

On page 113, reference is made in the first paragraph to the tool marks on the surface of the lands, etc. The tool marks referred to are those of a reamer and are circumferential, hence they cannot be communicated to the bullet. The marks on the grooves and land shoulders are those impressed upon the bullet, and are the ones we are mainly concerned with.

Referring to the article in the December issue, in the third paragraph on page 1065 the author speaks of "the marks made by the die in drawing the jacket of the bullet." These can have no bearing whatsoever on the subject. They will not even give a hint as to the maker of the ammunition. In the identification of bullets and shells, one must consider only those marks left by the gun (pistol, revolver, or rifle) on the bullet and on the cartridge case (shell).

At the bottom of the same page Professor Gunther refers to crimping. This has never been done on the .45 caliber auto-loading-pistol cartridge. This cartridge was originally made for the auto-loading pistol only and not for the revolver, though it can be used in the Model '17 revolver, either with or without the clip, but was not so used until some six months after the entrance of the United States into the World War. The shell is not crimped on to the bullet at the present time, either in the standard .45 auto-loading shell or the rimmed .45 auto as made for the revolver only.

On page 1066, in the third paragraph, reference is made to marks on the base of the primer as shown in Fig. 6. These marks could never have been placed on this primer in the process of ejection from a .45 auto-loading pistol, for in that process the shell travels some $^3/_{16}$ in. from the barrel before it is acted upon by the ejector. When the slide has moved backward a sufficient distance, the ejector, which is integral with the receiver or frame, strikes the cartridge case on the lower right-hand quadrant when viewed from the muzzle, or at "5 o'clock" in shooter's parlance. It will be easily seen that the primer is withdrawn from the firing-pin aperture radially instead of sliding downward or upward. The ejector acting as it does, would not permit the movement explained and illustrated.

The illustration shown is an exact duplicate of many seen where the cartridge has been fired from a Smith and Wesson or a Colt Model '17 revolver, in which the swing-out action of the cylinder causes the primer to be drawn across the edge of the firing-pin hole. This surface, being broached, would cause the marks shown on the primer. At the lower right-hand portion of Fig. 7 can be seen the outlines of the slot in which the ejector slides.

Page 1066, paragraph 6: "When a cartridge is chambered, etc." In all cases where the .45 auto-loading cartridge is used in a revolver, the cylinder is chambered to the exact shape of the shell, or as the barrel in the .45 auto-loading pistol is chambered, otherwise the cartridge could not be fired in the revolver without the clip.

As to the disturbing influence arising from the cylinder and barrel being out of line, this is something now rarely seen. It was prevalent in the old-time cheap revolvers, but their day is past. However, a reservation should be made to this statement, for quite a few of the cheap revolvers now imported into this country are in this condition. However, this is not evidenced by the shearing of lead from the bullet but by the fact that the base of the bullet is not at right angles to its axis.

Relative to Fig. 10 and to the author's description of the action of the firing pin, the inaccuracies or tolerances of manufacture of the various components of the ammunition will generally defeat the very reasoning that he would have us believe is infallible. A firing-pin imprint cannot generally be used as an identification unless the firing pin has a defect such as a crack, a scratch, or a chip out of one side.

C. G. WILLIAMS.[1]

Davenport, Iowa

TO THE EDITOR:

The comments submitted by Mr. C. G. Williams have been carefully studied. There is nothing in them which would justify changing in any way my statements as they appear in the two articles

CHARLES O. GUNTHER.

Hoboken, N. J.

A Plan to Promote Economic Stability

TO THE EDITOR:

Several recently published articles have recognized the need of labor's receiving a larger percentage of the earnings of industry as a means of creating economic stability, i.e., steady maintenance of production and consumption by proportional expansion of productive capacity and consumer purchasing power. The thought is predicated on the premise that the earnings of capital predominate in establishing the increment in capital available for reinvestment, and that the wages of labor predominate in establishing the capacity to consume.

The writer concurs in this belief, but further believes that the circumstances involving an ideal division of earnings in any one industry at any one time are so involved that a prompt, just, and effective solution of the problem is beyond the capabilities of any conceivable legislative body, planning board, or economic dictator.

In the present order of things the profit motive tends to insure adequate capital earnings to accommodate expansion and development. However, no similar automatic and immediately sensitive force is available to prevent capital earnings from exceeding the opportunity for profitable investment.

While, collectively, industrial leaders recognize the necessity of sustaining consumer purchasing power, individually they are forced by competition to reduce wages to protect their immediate interests. Viewed in this light, competition appears to be a destructive force responsible for continued deflation. But need it be so?

If the stated premise is correct, the problem of economic stability reverts directly to the problem of properly apportioning the earnings of industry between capital and labor. To obtain this result the writer proposes that competition be used to fight the destructive effects of competition, that high wages be made immediately profitable to the employer, as well as ultimately profitable to society as a whole.

The plan requires that every article sold in retail trade have plainly marked thereon the average hourly wage paid in its manufacture, and that the consuming public be educated through organized-labor societies and by competitive advertising by liberal manufacturers to favor brands paying the highest wages, prices and quality being equal. Value, as determined by individual judgment, would retain its primary importance in each transaction. The plan would operate to govern the choice between articles of equal value.

Here is the means of making high wages profitable even in the face of declining business. Not arbitrary, fixed, unjustly high wages, but relatively high wages, as high and only as high as any one industry at any particular time can justly pay, as determined by competition among the units of that industry. Here is a plan that is fundamentally and inherently stable, that makes justly high wages mandatory on any concern desiring to do business; that rewards and protects the effort to pay high wages and avoid panic if business conditions become poor; that allows unlimited freedom and profits in the field of new developments, but exerts the full influence of competition to keep down prices without abuse of labor in competitive fields, thereby limiting capital profits and discouraging investments in needless duplication of producing capacity in favor of development of new products.

The plan would encourage well-balanced operation of industry by distributing as wages the largest possible percentage of its earnings consistent with the demand for increased capital for expansion and development, departing radically from the principle of basing wages on the cost of living, striving simultaneously to reduce cost and increase wages, yet letting capital as a whole name the price for which capital will work. The plan recognizes the importance of capital to development and the importance of markets to capital. It entails no agreement or strife with capital, and cannot, by nature, be unreasonable.

A. E. KITTREDGE.[2]

Haddon Heights, N. J.

The Balancing of Economic Forces

TO THE EDITOR:

Permit the writer to express his personal gratitude for the publication of "The Balancing of Economic Forces" in the June issue of MECHANICAL ENGINEERING. This article, he believes, is the most courageous, intelligent, complete, and dispassioned analysis of the economic situation confronting modern society that has yet appeared in print.

The writer is entirely in accord with all the conclusions of the report, with possibly one important exception. As yet he is not quite prepared to agree that a unified and rationalized control of the whole economic structure is absolutely out of question. It seems to him that this point is still awaiting its concrete and definite proof.

As an engineer, the writer is willing to confess that he is particularly fascinated by the unlimited possibilities of such a plan. He bases his opinion, however, mainly on the experience of the World War in which, it seems to him, enough "beyond-human" knowledge and "beyond-human" skill was exercised for the savage and, as history shows, the only tangible purpose of killing ten million men in the prime of their life.

Why, then, cannot at least the same amount of intelligence, personal sacrifice, and effort be spared in peace time for the promotion of human welfare and happiness? Are not these objectives much more worth while?

This is more or less a matter of individual opinion—at least for the present—and the writer is not prepared to answer the

[1] 316 South 29th St. Mem. A.S.M.E.

[2] Jun. A.S.M.E.

question arbitrarily either way. The authors of the report, however, may be in a more advantageous position and they may have positive evidence on which to base their stand in regard to centralized economic control.

On the whole, however, this report merits still further publicity than it has received by appearing in Mechanical Engineering, and the writer suggests most seriously, therefore, that enough funds be appropriated by the engineering societies to print 100,000 copies (this number corresponds to the writer's estimate of the total number of persons in this country who are both able and *willing* to understand it) for gratis distribution to all bankers (including so called "international" bankers), industrialists, labor leaders, politicians, officials, executives, educators, the President of the United States, and the opposing candidates for that office.

Moreover, in all seriousness the writer proposes that this report be incorporated in a list of prescribed studies of all colleges and universities. It should be really committed to memory by all students taking a course in political economy. This, it is admitted, is an unattainable ideal, so he is willing to compromise on its thorough study for a period of three consecutive class hours, followed by a written examination consisting of answers to such questions as:

1 What is a general overproduction, and why it is so disastrous? Would the uncivilized natives of jungles seek solution of the problem by lowering their standard of living?

2 What is a favorable balance of trade, and why it is so called?

3 What is the relationship between the large cash surpluses of industrial corporations and prosperity?

4 What is the relationship between the large amount of gold in the national treasury, resulting partially from the sale of wheat abroad in peace time, and the economic security of the masses in face of such a combination of adverse circumstances as a blockade by a foreign nation and a crop failure?

5 What is instalment buying, and how does it differ from an attempt to lift oneself by one's bootstraps?

6 Why is trade with China so important for the increase in wealth of this country as to require the maintenance of armed force there for its protection?

7 What is the relationship between large foreign investments, a high tariff wall, and the collection of dividends, to say nothing of the principal of the aforesaid investments?

8 What is the connection between expert advertising and sales tactics, with resulting huge profits and sustained prosperity?

9 What is the connection between the rate of increase of wages previous to 1929, the rate of increase of productivity per worker, and the claim made in that year that high wages made possible a continuous prosperity?

10 What is the inevitable outcome if the achievements in the field of social engineering are allowed to lag behind the achievements in physical sciences and engineering proper at the same rate they are lagging now?

11 Taking a long-range point of view, what is the policy to be pursued by the engineering profession if its own interests as well as those of the society are not to suffer?

12 Do you know that, according to ornithologists, the ostrich has learned during his evolutionary period that, for the sake of sheer self-preservation, it is never safe to ignore a danger by refusing to face it, and that in this respect man is still several ages behind this unjustly accused bird?

S. D. Mitereff.[3]

Petersburg, Va.

[3] Jun. A.S.M.E.

Danger of Government Ownership

To the Editor:

In all the economic studies which have been published in Mechanical Engineering, I have not found that a great deal of attention has been given to the immediate danger of government ownership and operation which threatens. Both the tendency toward cutting wages and salaries more and more and the Reconstruction Finance Corporation are a menace to private ownership of business.

Should the government continue to lend money to the railroads and the banks and should it extend this lending to other corporations, it is just as certain to find itself the owner of some of these corporations as the manufacturer who extends liberal credit to his customers, taking bonds and stock in payment when cash is not available, eventually discovers that he is the owner and operator of the businesses of some of his customers. In other words, if the government begins to lend money to private business, there is grave danger that it will extend and continue this lending until there is government ownership and operation of more and more businesses.

Wage and salary reductions work toward the same end but from a different direction. It is certain that the cutting of wages and salaries in 1931 did not improve business conditions. What they did do was to reduce buying power, but what is still more important, they also gave rise to a fear to buy. Each salary and wage reduction since has increased this fear, with the result that many who are able to buy refuse to do so because of fear.

The interest on the investment in buildings, machinery, and equipment remains the same. Depreciation and obsolescence may actually increase when the plant is closed down altogether or operating at a fraction of capacity. Taxes may go up rather than down. These factors of cost increase the unit cost of production as production falls off.

Therefore, decreasing wages and salaries does not reduce production costs in proportion, if at the same time volume falls off. This means that, if pay-roll reductions continue, a point is reached where the pay envelope does not contain enough to provide food, lodging, and clothing for the family. When it does not contain enough, public aid must sooner or later be extended to this wage earner. In this case the manufacturer is being given indirect aid and such aid cannot be continued unless the government takes over the business.

Already some small concerns have cut wages down to below the starvation level. They have done it in most cases by adopting piecework rates and penalties which make it impossible for the wage earner to make a living. The only people who appear to be secure and are assured a living wage are those who are employed by the government. This is a condition of affairs which is filled with menace for private business. Those who are not earning a living and have had the means of doing so taken from them even though they work full time every week, have votes. They may be expected to vote for government ownership and operation if the present condition continues.

This is one reason why it might be much more profitable in the long run for employers to start increasing wages right now rather than to continue to decrease them. It should be kept in mind that our present corporations are much larger than were those of 1873, that all eyes are turned toward Russia, either in friendliness or in apprehension, that as unemployment increases unrest also increases, and that greater and greater demands are being made upon the government for aid, both by business and by those who are unemployed.

J. E. Bullard.[4]

Providence, R. I.

[4] Distribution Engineer. Assoc. A.S.M.E.

Effect of Temperature on the Properties of Metals

IN ITS progress report to the sponsor societies, the A.S.T.M. and the A.S.M.E., the Joint Research Committee on the Effect of Temperature on the Properties of Metals states that it has made measurable progress during the past twelve months despite the handicaps imposed by economic conditions. Curtailments in activities at some of the cooperating laboratories retarded progress in certain projects but, in general, the plans outlined a year ago were carried forward.

Probably the most important project under committee sponsorship which matured during the past twelve months was the second Symposium on the Effect of Temperature on the Properties of Metals, held at the Annual Meeting of the American Society for Testing Materials in Chicago, June, 1931. The 27 papers and voluminous discussions, together with a bibliography have been published in a bound volume of some 800-odd pages and provide an up-to-date summary of knowledge of the properties of metals for high- and low-temperature service and the engineering requirements of many important industries in this field. Two additional meetings were also held, one in New York in December, 1931, and one in Cleveland in March, 1932.

About eighteen months ago the Joint Committee and the sponsor societies approved plans for the establishment of a fund of $20,000 designed to enable the initiation of sponsored researches. These proposed activities were not intended to replace the cooperative researches already under way relating to problems requiring joint action such, for example, as the development of test codes for high-temperature tension tests and creep tests, but rather to take care of those fundamental problems involving prolonged effort and special equipment, which could not well be carried out in an accustomed manner.

Despite adverse economic conditions, the contributions already received will enable the Committee to carry forward its plans well into 1933.

Sponsored researches were initiated at two laboratories early this year. The work at the University of Illinois, under Prof. H. F. Moore, will relate largely to the endurance properties of austenitic nickel-chromium steels at different temperatures, and will be coordinated with creep tests at the Battelle Memorial Institute, under Dr. H. W. Gillett, as well as with studies at various industrial laboratories relating to the structural stability of these steels and the changes in various properties with time at high temperatures.

Consideration will be given to wrought and cast metals from the same melts and, in the case of 18 per cent chromium-8 per cent nickel steel, to the effects of carbon content and preliminary heat treatments on the chemical, mechanical, and structural stability of this widely used alloy steel.

At ordinary atmospheric temperatures the limiting stresses for design purposes are the repeatedly applied stresses (resistance to fatigue). While only a limited amount of data are available, there is evidence to indicate that the limiting stresses for steels at 1000 F are not the repeatedly applied stresses but the ability of the metal to sustain fixed loads (resistance to creep). Further information is needed to confirm these views and better to define in the case of the austenitic nickel-chromium steels the temperature ranges within which the repeatedly applied stresses and the ability to sustain fixed loads become the limiting stresses for design purposes.

The procurement of information of this sort is one of the important objects of these investigations and has considerable practical importance because of the widespread applications of austenitic nickel-chromium steels. It is also of scientific interest because most prior comparisons have been made on the pearlitic steels and the proposed tests should help to establish whether or not comparable relations exist in the austenitic steels.

Among the researches at cooperating laboratories which have been carried far enough to justify detailed reports are those relating to (1) a correlation of the tensile, creep, and fatigue properties of low-carbon boiler steel at different temperatures, (2) a cooperative study of the notched-bar impact properties, magnetic properties, and structure of the 18 per cent chromium-8 per cent nickel "stainless steels" under different conditions of treatment, and (3) a critical survey of the variations and variables in cooperative creep testing of a chromium-molybdenum steel.

Important articles relating to the effect of temperature on the properties of metals are now abstracted regularly and published monthly under a separate heading in the abstract section of *Metals and Alloys*. This provides continuous contact with progress in this and foreign countries as recorded in technical literature and replaces the previous plan of issuing bi-annual additions to the bibliography on effect of temperature on metals first published by the A.S.M.E. in 1928.

Alloys of Iron Research

ACCORDING to a progress report issued in June on the Alloys of Iron Research under The Engineering Foundation, substantial progress has been made in both phases of the work during the past year. The critical survey of research on iron and its alloys, as reported in the technical literature of the world from 1890 to date, is more than 50 per cent complete, and the publication program is well advanced. The manuscript for the first monograph, on iron-molybdenum alloys, has been delivered to the publisher, McGraw-Hill Book Company; another, on iron-silicon alloys, is completed and will soon be ready for pre-publication issue to consulting editors and participants; a third and fourth (iron-tungsten and iron-copper) are partly written. Work has been started on a fifth and sixth (pure iron and iron-nickel), and plans have been made for four more, respectively, on iron-chromium, iron-vanadium, iron-manganese, and iron-carbon alloys.

To accomplish the most thorough survey in the shortest time the review to date by the editorial office has been confined to the most important metallurgical journals; more than half of these, in English, German, French, Swedish, and Italian, have been abstracted and all information of value for monographs and manuals has been extracted and filed. From these journals 3540 technical and scientific papers have been reviewed and 9419 abstracts prepared.

A table accompanying the report reveals the interesting fact that alloys of iron with all of the selected elements have received some attention from researchers. Even the alloys of iron with rare metals including gold, platinum, iridium, and others have been investigated.

The literature survey is rapidly approaching the stage where the editorial office will have available a critical summary of all important papers recording research on ferrous metals, published since 1890. When completed, this survey should be of great value to those researchers or technicians who wish to review rapidly past work in the fields in which their interests lie.

Plans are being made for a number of manuals and one, iron-silicon, has been authorized. No work has, as yet, been done on this phase of the publication program.

BOOK REVIEWS AND LIBRARY NOTES

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the United Engineering Trustees, Inc., as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Hydraulics of Open Channels

Hydraulics of Open Channels. By Boris A. Bakhmeteff. McGraw-Hill Book Company, Inc., New York. 1932. Cloth, 6 × 9 in., 329 pp., 225 figs. and 7 supp. plates, $4.

Reviewed by Robert W. Angus[1]

THIS book is one of the Engineering Societies Monographs published through the assistance and cooperation of the four national engineering societies, the A.S.C.E., A.S.M.E., A.I.M.E., and A.I.E.E., these societies having undertaken to assist in the publication of certain books that might not otherwise be marketed. In this case the work appears to be well worthy of its sponsors.

Problems relating to the flow in open channels have always given much difficulty, partly because of the large number of variables they involve, and while certain approximate formulas have been devised, these are mostly very limited in application and cannot be fitted to most cases that arise in practice. The author of this book, Prof. B. A. Bakhmeteff, now of Columbia University, and formerly a professor in Petrograd, has endeavored to bring the problem under a somewhat systematic treatment, which is new to the writer at least. Problems of uniform flow offer little difficulty, but non-uniform flow, such as that caused by dams, waterfalls, etc., is another matter, and the mathematical solution with which many hydraulic engineers are familiar is that involving the "backwater function," which requires a complete table, and is limited to a special and unusual practical case.

The author of this book presents a different method. The well-known Chézy formula has been adopted, together with any desired formula such as Kutter's, Manning's, Bazin's, etc., for the coefficient, and a term called the "conveyance" of the channel has been established by dividing the discharge at any depth by the square root of the bottom slope. A curve of conveyance against depth must then be plotted for the channel, which provides a smooth curve, and the author then shows that for any selected cross-section the square of the conveyance is proportional to the depth of water in the section raised to the nth power, for reasonable ranges of depth. He further shows that this value of n will be between 2 and 5.5, depending on the shape, size, and condition of the channel, but the actual value of the exponent for any case is easily found by logarithmic plotting. Using different values of n, tables have been made by the author which enable a great variety of variable-flow problems to be solved.

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To illustrate the methods of the book, a large number of numerical examples have been worked out for different typical cross-sections, with small and large bottom slopes, and the natural water course with its irregular cross-section and slope have been given consideration. The last part of the book is devoted to the hydraulic jump, nearly 70 pages being employed for this purpose.

To give definite ideas of the nature of the material presented, one or two problems may be quoted. The surface curve has been determined for a canal of uniform bottom slope ending in a fall of various depths, then a second problem of a similar canal joined to another of greater slope; and still another case of the second slope being smaller than the first. But the canal may discharge into a pool with its water surface well above the discharge end of the canal, so that case is also worked out.

Another very important problem that must be solved for every open channel is its limiting capacity; the author's method appears to suit this case very well, and he shows the effect of entry and other conditions on this capacity. Naturally, that is the same problem as the design of a canal, but a complete chapter is devoted to the latter problem and its application in certain specific cases.

Without having time to use the author's methods, it is impossible to say whether they are simpler and less tedious than others now in use, but the illustrations given would suggest that the method is readily carried out, and since great care has been taken to keep complicated mathematics from the main part of the book, no practicing engineer need have any hesitation in consulting it. The book is a distinct contribution to the subject, has been prepared and printed in excellent form, and is well illustrated; it should find a place in the library of the hydraulic engineer.

Earthquake Damage and Earthquake Insurance

Earthquake Damage and Earthquake Insurance. By John R. Freeman. McGraw-Hill Book Co., New York and London, 1932. Cloth, 6 × 9 in., 904 pp., illus., charts, maps, tables, $7.

Reviewed by Rev. John Joseph Lynch, S. J.[2]

IN THIS monumental work John R. Freeman tells of a life's research for the better protection of his fellow-men. Though entitled "Earthquake Damage and Earthquake Insurance," it might more reasonably have been entitled an "Earthquake

[2] Seismologist, Department of Physics, Fordham University, New York, N. Y.

Encyclopedia." An encyclopedia it certainly is, treating as it does practically every phase of seismology and giving abundant references from the standard seismological works in English and in foreign languages. It will prove of immense help to the seismologist because of its complete index and its references to the more important works on each topic. Nowhere, for instance, will there be found as complete a summary of earthquake intensity scales as Dr. Freeman gives in connection with his treatise on earthquake violence.

However, though an encyclopedia and treating, at least briefly, almost every phase of seismology, its main object is to give a true picture of what to expect from an earthquake and how to protect against one—to take the sting out of earthquakes, as it were. This he has succeeded in doing. Quoting excellent authorities and after careful analysis of the past, he has given us a conservative view of what we may expect as to the number and severity of quakes in the future. While Japan may expect a severe earthquake every few years, one in every twenty-five is the estimate for the Western United States and one in every hundred for the East, with the probability that no future quake will be more severe than those in the past. In one hundred years only nine hundred and sixty persons have been killed by earthquakes in the United States. More than this number are killed annually in each of our larger cities by automobiles. Earthquake fatalities in this country, therefore, must be put down as a very small item.

But even in the most disastrous earthquakes, well-designed buildings have successfully resisted the shock, showing conclusively that buildings can be made earthquake-proof. One notable example given in detail is that of the Imperial Hotel in Tokyo, in which not even the water mains or conduits were broken—the building was constructed to ride with the shock rather than resist it, being balanced much as a waiter's tray is balanced on his fingers. The point is brought out emphatically and clearly, with the support of the eminent Japanese authority, Professor Suyehiro, that even in the violent Japanese earthquake, buildings which had been designed to resist a horizontal force of one-tenth of their weight, successfully withstood the shock. The increased building cost to provide this necessary resistance to earthquake shock has been carefully figured and is ridicuously small—about fifteen per cent. Even if quakes come, therefore, and but few are to be expected, they can with a little forethought and a little extra trouble in building construction, be effectively provided against.

But sometimes our best plans go astray. Even with precautions it is possible that some damage may result. This may be taken care of by a moderate insurance premium. Dr. Freeman has shown that earthquake risk has in the past been enormously exaggerated. Even in the most disastrous quakes, the actual damage has always been confined to a comparatively small area, and careful analysis of the past reveals the assuring fact that the actual loss seldom exceeds five per cent of the structural value. Were the full facts made clear both to the public and to the insurance companies, both would be better served—premiums would be reduced, helping the insured, and insurance be more generally taken out, helping the companies. Dr. Freeman offers the practical suggestion that fire-insurance companies could include earthquake risk at a nominal extra cost were such cooperation between insurer and insured effected.

Dr. Freeman has done a splendid work in gathering all known facts on earthquake damage and earthquake insurance and putting them before the public for their use and help. Much damage in past quakes could have been prevented by proper building, and indemnity cheaply provided by insurance.

But while Dr. Freeman has put forth all known facts, he has the hunger of Oliver Twist for more. He had long cried to the seismologist for more information on exactly what happens at the scene of the quake. His insistence has been almost embarrassing at times, but the desired information is slowly forthcoming, and seismology is grateful to Dr. Freeman for his patient and very helpful perseverance.

Dr. Freeman has done a splendid work for the seismologist, the engineer, the insurance man, and the general public. His book should be on the library shelves of all four groups. He has brought the horse to water—the animal itself must drink.

Books Received in the Library

ABRISS DER STRÖMUNGSLEHRE. By L. Prandtl. F. Vieweg & Son, Braunschweig, 1931. Paper, 7 × 10 in., 223 pp., illus., diagrams, charts, tables, 13.80 rm.; bound, 15.40 rm. This treatise on the flow of fluids is intended to provide a brief, yet comprehensive and easily understandable, account of the subject, in which mathematical treatment is reduced to small proportions. In large part, the text is taken from Dr. Prandtl's contribution to Mueller-Pouillet's "Lehrbuch der Physik," but it has been expanded and brought up to date.

AIRCRAFT YEAR BOOK, vol. 14, 1932. By Aeronautical Chamber of Commerce. D. Van Nostrand Co., New York, 1932. Cloth, 6 × 9 in., 626 pp., illus., diagrams, charts, maps, tables, $6. The first division of this year book records the outstanding events of the year in aviation, both in America and elsewhere. Part two deals with progress in engineering and manufacturing, and includes drawings of American aircraft and engines. In the third part is found a chronology of important contests and records. Succeeding parts give useful statistics and a directory of officials, associations, etc. The book is a convenient summary of information upon all matters of aviation, which will be found useful by every one interested in the subject.

AIRPLANE AND ITS ENGINE. By C. H. Chatfield and C. F. Taylor. Second edition. McGraw-Hill Book Co., New York, 1932. Cloth, 6 × 8 in., 443 pp., illus., diagrams, charts, tables, $3. This work will be useful to students and general readers in search of an elementary but comprehensive account of the basic principles of the airplane and its power plant, and a broad view of present development in this field. The new edition has been revised and brought up to date.

AMERICAN SOCIETY FOR TESTING MATERIALS. Index to Proceedings, Vols. 26–30, 1926–1930. A.S.T.M., Philadelphia, 1932; 251 pp., 6 × 9 in.; cloth, $1.75; half leather, $2.75 to members; cloth, $2.50, half leather, $3.50 to non-members. This full subject and author index to these volumes of the proceedings of the society will be welcomed by all those interested in the testing of materials and the study of their properties. It supplements the index to the first twenty-five volumes which appeared some years ago.

BARRAGES CONJUGUÉS ET INSTALLATIONS DE POMPAGE. By G. Laporte. Gauthier-Villars et Cie, Paris, 1932. Paper, 7 × 10 in., 144 pp., diagrams, charts, tables, 35 frs. The economic possibilities of increasing the output of hydroelectric plants by pumping water back into storage reservoirs with off-peak power are investigated here, especially for the case where two or more plants are installed upon a river and operated together. The various feasible plans of pumping are discussed, and the characteristics of the pumping plants suited to each are determined.

BERICHT ÜBER DIE 1. KORROSIONSTAGUNG am 20. Oktober 1931 in Berlin. V.D.I.-Verlag, Berlin, 1932. Paper, 6 × 8 in., 136 pp. illus., diagrams, charts, tables, 7.50 rm. A report of a conference, upon corrosion held in Berlin in 1931, under the auspices of the engineering, chemical, and metallurgical societies of the country. Twelve papers were presented by well-known students of the subject, in which different aspects of the subject were considered. Several papers discuss broad general problems. Others deal with practical matters such as corrosion of high-pressure boilers and of ships. Several papers discuss corrosion tests, and the three final papers treat of methods of protection and prevention.

BIBLIOGRAPHY OF AERONAUTICS, 1930. National Advisory Committee for Aeronautics. U. S. Government Printing Office, Washington, D. C., 1932. Paper, 7 × 10 in., 261 pp., $0.50. Covers the aeronautical literature published during 1930 and includes references to articles in the principal periodicals of the world, reports of aeronautical research organizations, etc. Articles are entered under author

and subject in one alphabet. The volume continues a series which covers the subject from early times.

Chemische Technologie der Neuzeit. Vol. 2, Part 1. By O. Dammer. Second edition, edited by F. Peters and H. Grossmann. Ferdinand Enke, Stuttgart, 1932. Paper, 8 × 11 in., 876 pp., illus., diagrams, charts, tables, 75 rm.; bound, 79 rm. The first section of this volume is a comprehensive account, covering 363 pages, upon the manufacture and properties of the industrial metals and alloys. Included in this is a dictionary of nearly fifteen hundred useful alloys, with their compositions, and a brief but well-selected bibliography. The second section discusses the question of corrosion and its prevention, electroplating and electrotyping, fire gilding, and metal coloring. Section three is devoted to the preparation of ores for smelting. This new edition of this valuable work is greatly enlarged and will be found most useful for reference.

Die Dampfturbinen. Part II. (Sammlung Göschen Bd. 715.) By C. Zietemann. Walter de Gruyter & Co., Berlin and Leipzig, 1932. Cloth, 4 × 6 in., 134 pp., diagrams, charts, tables, 1.80 rm. The design and construction of steam turbines are here presented with extreme conciseness. Mathematical requirements are reduced to the minimum. The practical application of the methods is illustrated by worked-out examples, and references for further study are given.

Elements of Human Engineering. By C. R. Gow, edited by F. A. Magoun. Macmillan Co., New York, 1932. Cloth, 5 × 8 in., 169 pp., $1.60. The second of a series of books by the professor of humanics at the Massachusetts Institute of Technology. From his broad practical experience, Professor Gow gives sensible advice to the young engineer who is beginning his career upon the cultivation of correct personal relations with superiors and subordinates and similar topics that greatly affect his success in life but are not covered in his course of study.

Faraday and Maxwell. (Deutsches Museum Abhandlungen und Berichte, Jahrg. 4, Heft 1.) By E. Cohn. V.D.I.-Verlag, Berlin, 1932. Paper, 6 × 8 in., 29 pp., illus., diagrams, 90 rm. The centenary of Maxwell's birth and Faraday's great discovery occurred in 1931. This essay links the lives and work of these geniuses in a most interesting way, showing how our present conception of the principle of energy evolved from Faraday's experiments through Maxwell's studies.

Gasoline Automobile. By B. G. Elliott and E. L. Consoliver. Fourth edition. McGraw-Hill Book Co., New York and London, 1932. Cloth, 6 × 9 in., 605 pp., illus., diagrams, tables, $3. The fundamentals of automobile construction, maintenance, and operation are set forth in this work with sufficient fullness for the needs of the owner, operator, repair man, and student. The text is clear and explicit, and amply illustrated with photographs and drawings. The revision has been thorough and complete.

Gasoline Automobiles. By J. A. Moyer. Fourth edition. McGraw-Hill Book Co., New York and London, 1932. Cloth, 5 × 8 in., 509 pp., illus., diagrams, charts, tables, $2.75. The essential principles of automobile construction and operation are presented clearly in this volume, which is especially fitted to the needs of drivers and owners. The information is presented in simple, clear language. This edition includes such recent innovations as free-wheeling, dual transmission, floating power, synchro-mesh transmissions, etc.

Handbook of the Collections Illustrating Land Transport. III. Railway Locomotives and Rolling Stock. Part 1. Historical Review. By E. A. Forward. South Kensington Science Museum, London, 1931. Paper, 6 × 10 in., 99 pp., illus., 2s. 6d. This pamphlet provides a very useful, concise review of the development of the locomotive and the railroad car in the British Isles. The locomotive occupies most of the space, and its evolution is expertly traced from Trevithick's experiments in 1801 to the latest types. Electric and internal-combustion engines are included. The illustrations are very satisfactory.

High-Speed Diesel Engines. By P. M. Heldt. P. M. Heldt, Philadelphia, 1932. Cloth, 6 × 9 in., 312 pp., diagrams, charts, tables, $4. Although there are a number of books on Diesel engines, this is the first American book treating specifically of the high-speed oil engine for automotive use. It aims to give an orderly, condensed review of the research work that has been done in America and Europe on the problems connected with design, with descriptive data and illustrations of typical examples of the various sub-classes that have been built. The book brings together a large amount of material of interest to designers and experimenters, especially about automobile and aircraft engines, which has been widely scattered and difficult to collect.

Illustrierte Technische Wörterbücher, Deutsch, Englisch, Französisch, Italienisch. Vol. 17. Aeronautics. Edited by A. Schlomann. V.D.I.-Verlag, Berlin, 1932. Cloth, 7 × 10 in., 740 pp., diagrams, 30 rm. This volume follows the general plan of the series to which it belongs, the terms being arranged systematically, with indexes in German, French, Italian, and English. About 13,000 terms are included. Illustrations are used freely to make meanings clear. The book has been prepared with the assistance of a number of engineering societies and firms, aviation boards, and government bureaus. It is far superior to any other dictionary available, and will be welcomed by every translator.

Internal-Combustion Locomotives and Motor Coaches. By I. Franco and P. Labryn. Van Riemsdyck Book Service, New York, 1931. Cloth, 7 × 10 in., 249 pp., illus., diagrams, charts, tables, $4. Though much has been written about internal-combustion locomotives and railway motor cars, this material is chiefly scattered through various periodicals, and this monograph, which brings the information together, will be very useful to railroad engineers and students. The engine and the transmission are discussed, after which the types of locomotives and motor cars that have been built are described in detail. Finally, general conclusions are drawn as to the field for these engines in railroad work. There is a bibliography of books and of articles in the leading American and European railroad periodicals.

International Unemployment—A Study of Fluctuations in Employment and Unemployment in Several Countries, 1910–1930. M. L. Fleddérus, editor. International Industrial Relations Institute, The Hague, Holland, and New York, 1932. Cloth, 7 × 10 in., 496 pp., charts, tables, $2.50. In preparation for the Social Economic Congress held at The Hague in 1931, various economists were asked to prepare studies of fluctuations in employment in different countries which would picture the recurrence of unemployment during the last two decades. These studies, presented in this volume, show conditions in Australia, Canada, China, Germany, France, Great Britain, the United States, and Russia, and are important factual presentations.

Introduction to Theoretical Seismology. By J. B. Macelwane and F. W. Sohon. Part 2. Seismometry. By F. W. Sohon. John Wiley & Sons, New York, 1932; 6 × 9 in., 149 pp., illus., diagrams, charts, tables, $2.75. A presentation of the mathematical theory of the seismograph, which aims to give the observer an understanding of the principles that underlie that instrument and enable him to test and adjust it and understand its behavior and shortcomings. It is claimed to be the first book in English on the mathematical theory of the seismograph.

Load Curves and Power Indexes in the Operation of Electric Stations. (In Russian.) By A. K. Darmanchev. Gosudarstvennoe Nauchno-Tekhnicheskoe Izdatelvstvo, Moscow and Leningrad, 1931. Paper, 6 × 9 in., 119 pp., diagrams, charts, tables, price not given. Load curves are usually discussed, according to Mr. Darmanchev, solely in relation to the layout of power plants. In the present book they are considered from the viewpoint of station operation. The theory of load curves is set forth, and the ways in which they may be applied are described in detail.

Das Maschinenzeichnen. (Sammlung Göschen, Bd. 589.) By W. Tochtermann. Walter de Gruyter & Co., Berlin and Leipzig, 1932. Cloth, 4 × 6 in., 154 pp., diagrams, charts, tables, 1.80 rm. A concise, practical textbook on mechanical drawing, intended for schools and self-instruction.

Mechanical Fabrics—A Treatise Upon Their Manufacture, Construction, Testing, and Specification. By G. B. Haven. John Wiley & Sons, New York, 1932. Cloth, 6 × 9 in., 905 pp., illus., diagrams, charts, tables, $10. This book is intended for those interested in research upon fabrics for automobile tires, balloon gasbags, airplane wings, hose, belting, and other mechanical members where strength, uniformity, and similar characteristics are the important ones. The raw materials used for these fabrics, the methods of manufacture, the equipment of laboratories, and the methods of testing physical qualities are discussed. The volume will be valuable to users of these fabrics as well as to manufacturers.

Metallurgy. By E. Gregory. Blackie & Son, London and Glasgow, 1932. Cloth, 6 × 9 in., 284 pp., illus., diagrams, charts, tables, 17s. 6d. An introduction to the subject by an experienced teacher,

which gives a simple, interesting account of the manufacture, properties, and uses of the common engineering metals. The metallurgy of ferrous materials fills two-thirds of the book and includes chapters on the constitution of metallic systems, metallography and heat treatment, alloy steels and stainless steels. The remainder of the work treats of common non-ferrous alloys.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN GHH-KONZERN. Vol. 1, No. 10, pp. 225–256, March, 1932. V.D.I.-Verlag, Berlin. Paper, 9 × 12 in., illus., diagrams, charts, tables, 3.60 rm. The reports in this pamphlet come from the laboratories of various industrial plants in Germany. The first deals with the fatigue resistance of welded steel frames for machines. The second treats of heat losses by radiation from boilers. The third describes a new apparatus for testing the cutting properties of metals and gives the results of trials with various materials.

MITTEILUNGEN DER DEUTSCHEN MATERIALPRÜFUNGSANSTALTEN. Special No. 19. Julius Springer, Berlin, 1932. Paper, 8 × 12 in., 104 pp., illus., diagrams, charts, tables, 16.50 rm. Contains contributions from the Staatlichen Materialprüfungsamt and the Kaiser Wilhelm-Institut für Metallforschung upon various recent investigations upon the properties of metals. Fifteen papers are included, upon a variety of topics. Among these are the physics and metallography of sheet aluminum, the origins of boiler failures, the roll texture of cadmium, the tearing of cold-drawn iron rods, studies of copper-tin and copper-zinc alloys and silver-palladium and gold-palladium alloys, the mechanics of deformable substances, etc.

MITTEILUNGEN DES INSTITUTES FÜR STRÖMUNGSMASCHINEN DER TECHNISCHEN HOCHSCHULE KARLSRUHE. No. 2. By W. Spannhake. V.D.I.-Verlag, Berlin, 1932. Paper, 8 × 11 in., 175 pp., illus., diagrams, charts, tables, 4 rm. The investigations described in this publication have as their object the elucidation of the phenomena that occur in centrifugal pumps and turbines. They include a theoretical study of the hydrodynamics of ideal flow in turbines, and experimental studies of turbulent flow through annular tubes, of flow in hollow vessels, and of a new type of turbine draft-tube.

LES MOTEURS A DEUX TEMPS RAPIDES Á EXPLOSION ET À COMBUSTION. By O. Fuscaldo. Dunod, Paris, 1932. Paper, 6 × 8 in., 114 pp., diagrams, 22 francs. The author of this interesting book believes that the future internal-combustion engine will be a two-cycle engine, and that its accomplishment will solve the problem of the heavy-oil engine. In the present work he reviews the results already attained by himself and other investigators, and points out the problems that still await solution.

NACHTRAG III ZUM WERKSTOFFHANDBUCH NICHTEISENMETALLE. Beuth-Verlag, Berlin, 1932. Paper, 6 × 8 in., 14 pp., illus., diagrams, tables, 3.50 rm. This third supplement to the Handbook of Non-Ferrous Metals contains new information upon torsion testing, corrosion testing, electric melting furnaces, metal coatings, and the working of pure aluminum. The material is in loose-leaf form for insertion in the Handbook.

PROFITABLE PRACTICE IN INDUSTRIAL RESEARCH. Edited by M. Ross, M. Holland, and W. Spraragen; prepared under the auspices of the National Research Council. Harper & Brothers, New York and London, 1932. Cloth, 6 × 9 in., 269 pp., tables, $4. A symposium by the directors of some of the greatest industrial-research laboratories of the country. Among the topics discussed are the philosophy and practical application of industrial research, the organization of research departments, the selection of research workers, research work in foreign countries, the part played by trade associations, the government and universities, and the transference of the results of research to the factory.

PRINCIPLES OF PUBLIC UTILITIES. By E. Jones and T. C. Bigham. Macmillan Co., New York, 1931. Cloth, 6 × 9 in., 799 pp., charts, tables, $4.25. A text on the economics of public utilities, designed for use as a textbook by students and as a manual by officials, engineers and others interested in public-utility problems. The discussion is confined to the utilities supplying electric light and power, gas, street railway service, telephone service, and water. The subjects treated include regulation, valuation, rates, finances, combinations, public ownership, and other outstanding problems.

QUERSCHNITTE DURCH DIE INGENIEURFORSCHUNG. Sonderdrucke zusammenfassender Berichte über V.D.I.-Forschungshefte (aus der Zeitschrift Forschung auf dem Gebiete des Ingenieurwesens, 2. Jahrg.). V.D.I.-Verlag, Berlin, 1932. Paper, 9 × 12 in., 48 pp., illus., diagrams, charts, 3 rm. For more than thirty years the Society of German Engineers has published the results of scientific research work periodically in the "Forschungsarbeiten auf dem Gebiete des Ingenieurwesens." The present publication contains reports summarizing and evaluating the contents of all these articles in six important fields: hydrodynamics, thermodynamics, combustion and internal-combustion engines, boilers and steam engines, heat transmission, and engineering materials. Over four hundred reports are summarized in most convenient form, with references to the original publications.

RAMBLING THROUGH SCIENCE. By A. L. De Leeuw. McGraw-Hill Book Co., New York and London, Whittlesey House, 1932. Cloth, 6 × 9 in., 320 pp., diagrams, $2.50. Readers without special training in modern chemistry, physics, and astronomy will find much satisfaction in these informal chapters. Mr. De Leeuw writes conversationally, simply, and clearly about light, sound, relativity, time, space, energy, matter, the elements, and other physical and chemical problems, giving an account of many recent scientific discoveries which can be understood by every one.

REGELN FÜR DIE DURCHFLUSSMESSUNG MIT GENORMTEN DÜSEN UND BLENDEN. DIN 1952. Second edition. V.D.I.-Verlag, Berlin, 1932. Paper, 8 × 12 in., 20 pp., diagrams, charts, tables, 2.70 rm. The rules for metering fluids by means of standard nozzles and orifices here presented have been prepared by a committee of the Society of German Engineers. The theory of the methods is presented, the German standard nozzles and orifices are shown and their tolerances and corrections given, and the practical use of the rules explained. There is a short bibliography.

ROYAL TECHNICAL COLLEGE JOURNAL. Vol. 2, Part 4. Robert Anderson & Sons, Glasgow, January, 1932. Paper, 7 × 10 in., pp. 571–710, illus., diagrams, charts, tables, 10s. 6d. This records some research work recently carried out in the College. Among the topics of most interest to engineers are the physical properties of steel after plastic and yield-point extension, magnetostriction of cold-drawn wire, aging and tempering duralumin, segregation in steel, production of uniform illumination over large areas, the photoelectric cell, temperature stresses in non-circular drums and circular flat plates, and the performance of wing radiators.

SYMPOSIUM ON EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS. The American Society of Mechanical Engineers, New York, and American Society for Testing Materials, Philadelphia, 1932. Cloth, 6 × 9 in., 829 pp., illus., diagrams, charts, tables, $6 to non-members; $5.50 to members. These papers were presented at a joint meeting of The American Society of Mechanical Engineers and the American Society for Testing Materials in Chicago, 1931. Twenty-seven papers were presented, discussing various problems related to engineering trends and requirements for metals at high and low temperatures, and the properties of metals for use at these temperatures. The book summarizes ably our present knowledge of the subject, and brings up to date the record prepared at a similar meeting in 1924. A bibliography is included.

TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMÉRIQUES DE CHIMIE, DE PHYSIQUE, DE BIOLOGIE ET DE TECHNOLOGIE, Vol. 9, 1929. Gauthier-Villars et Cie, Paris; McGraw-Hill Book Co., New York, 1931. Cloth, 9 × 11 in., 1607 pp., charts, tables, $12. With this issue this important reference work is again upon an annual basis. The present volume contains all the constants and numerical data in the fields of chemistry, physics, biology, and engineering which were published during 1929. The series is an indispensable supplement to the "International Critical Tables" and is essential to every research worker. The text is in both English and French.

THÉORIE ET TECHNOLOGIE DES ENGRENAGES. Vol. 2. Métallurgie, Forge, Fonderie, Taille, Rectification, Rodage, Problèmes annexes. By J. Perignon. Dunod, Paris, 1932. Paper, 7 × 10 in., 299 pp., illus., diagrams, charts, tables, 72 francs; bound, 81 francs. Having disposed of the theory of gears in his first volume, Mr. Perignon now turns to their manufacture. This volume is a practical treatise upon the forging and casting of blanks, methods of cutting, cutting machines, inspection, and other problems.

DIE VORKALKULATION VON ARBEITSZEITEN FÜR SPANABHEBENDE BEARBEITUNG. (Sammlung Göschen, Bd. 1001.) By H. Freund. Walter de Gruyter & Co., Berlin and Leipzig, 1932. Cloth, 4 × 6 in., 119 pp., diagrams, charts, tables, 1.62 rm. An elementary textbook upon the use of time studies and knowledge of cutting speeds for calculating in advance the output from lathes and other cutting tools. Intended for beginners.

CURRENT MECHANICAL ENGINEERING LITERATURE

Selected References From The Engineering Index Service

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AIRPLANE ENGINES

INSTALLATION. Triebwerkanordnungen ber Mehrmotorenflugzeugen, A. R. Weyl. Zeit fuer Flugtechnik und Motorluftschiffahrt v 23 n 8 Apr 28 1932 p 213–19. Comparison of methods of installation and location of power plants in multi-engined airplanes, with particular regard to aerodynamic efficiency, structural problems, and accessibility.

AIRPLANES

LANDING GEAR. Wheel Brakes and Undercarriages, S. Scott-Hall. Roy Aeronautical Soc—J v 36 n 257 May 1932 p 386–421 and (discussion) 421–32. Design and performance of principal types of brakes and landing gears, with particular regard to ability of absorbing heavy landing shocks; layout of controls and use of fairings; energy absorption of different types of tires.

ALLOY STEELS

PROPERTIES. Relative Merits of Some Different Alloy Steels With Respect to Certain Mechanical Properties, B. Stoughton and W. E. Harvey. Lehigh Univ Pub v 5 n 7 July 1931 17 p. Taking as basis about 50 binary or ternary steels whose chemical analyses and mechanical properties have been published, 1800 numerical calculations were made; preliminary discussion of results. Bibliography.

ALLOYS

ALUMINUM. See *Aluminum Alloys*.

BEARING METALS. See *Bearing Metals*.

BRASS. See *Brass*.

CHROME-NICKEL. See *Chrome-Nickel Alloys*.

ALUMINUM

SOLDERING. Gekoerntes Aluminum-Schlaglot, L. Rostosky. Hauszeit der V. A. W. u.d. Erftwerk A.G. fuer Aluminium v 4 n 3 Mar 1932 p 73–4. Use of special aluminum solder in grain form with melting temperature 120 C less than aluminum.

ALUMINUM ALLOYS

ALUMINUM BRONZE. Applications diverses du bronze d'aluminium, G. H. Meigh. Revue de Métallurgie v 29 n 4 Apr 1932 p 208–14. Various applications of aluminum bronze, with particular reference to its resistance to wear; difficulties in casting; it is claimed chemical composition has only slight influence on anti-friction properties, if certain defined limits of composition are adhered to; problem of friction; study of chemical attack and galvanoplastic effect; oxidation and crystallization.

AMMONIA COMPRESSORS

CONTROL. Unloaders for Motor Driven Compressors, G. E. Swift. Refrig Eng v 23 n 4 Apr 1932 p 215–18. New type of automatic unloader for ammonia compressors eliminates need of manual by-passing; permits automatic start-and-stop operation for synchronous motor-driven plants; unloader operates instantaneously, preventing shutdowns during voltage dips; simplifies operation of starting and improves plant reliability.

ASH HANDLING

SCAVENGING PROCESS. Entaschung nach dem Spuelverfahren. Braunkohle v 31 n 19 May 7 1932 p 332–4. Ash removal according to scavenging process; discussion of article by Harraeus previously indexed from Jan 9 1932 issue of same journal on hydraulic ash-removal plants; advantages of scavenging system and example of plant installed in boiler house of Boehlen power plant, Germany.

AUTOMOBILE ENGINES

CRANKSHAFTS. How Buick Machines Its Crankshaft, B. Finney. Iron Age v 129 n 20 May 19 1932 p 1114–15 and (adv sec) 20. Crankshaft is milled to length on rotary mill and ends are centered on special machine; oil holes are drilled in crankshaft on battery of drills equipped with hydraulic automatic control; studs welded to counterweight; pins and bearings are lapped on crankshaft lapping machine.

LUBRICATION. Beobachtungen an Motorschmieroelen im Betriebe, C. Ehlers. Verkehrstechnik n 12 Apr 25 1932 p 224–6. Testing of automobile-engine lubricating oils during operation; results of 5 different trends tabulated and shown in curves; oil analysis; cylinder wear.

Control of Bearing Temperature in High-Speed Petrol Engines, C. G. Williams. Engineering v 133 n 3457 and 3459 Apr 15 1932 p 464–6 and Apr 29 p 523–5. Effect of engine speed on liability to failure of big-end bearings; influence of direct cooling of bearings by air in crankcase; by arranging for automatic adjustment of temperature of air supplied to crankcase, it is possible to control oil temperature within narrow limits under wide range of conditions; results of experiments in which effectiveness of such arrangement was tested.

AUTOMOBILES

DESIGN. Fahreigenschaften und Wirtschaftlichkeit in ihrer Abhaengigkeit von Getriebeuebersetzung und Vergaserregulierung, A. Jante. Automobiltechnische Zeit v 35 n 8 and 10 Apr 25 1932 p 195–8 and May 25 p 255–7. Graphical interpretation of relations between performance and economy and gear ratio and carburetor adjustment.

AUTOMOTIVE FUELS

COMPRESSED GAS. Les gaz combustibles comprimés, H. Beissac. J des Usines à Gaz v 56 n 7 and 8 Apr 5 1932 p 145–56 and Apr 20 p 181–90. Recent progress in industrial application of compressed gas with particular regard to its use as fuel on motor vehicles and for domestic purposes; layout and operating characteristics of compressor plants and distribution of compressed gas in containers; economic aspects.

DETONATION. Formation de peroxydes dans l'oxydation des hydrocarbures—application au phenomene du choc, P. Mondain-Monval. Chimie et Industrie v 27 n 4 Apr 1932 p 770–4. Formation of peroxides in oxidation of hydrocarbons; application to phenomenon of detonation in internal-combustion engines; direct oxidation of hydrocarbons saturated with air; results of tests.

DIESEL-ENGINE FUELS. Fuels and Engine Knock, C. B. Dicksee. Mech World v 91 n 2359 Mar 18 1932 p 269–71. Classification of fuel oils on basis of performance and physical properties; control of ignition lag by blending.

GERMANY. Einheitstreibstoff? H. Mueller. Automobil Rundschau v 34 n 8 and 9 Apr 20 1932 p 143–6 and May 5 p 166. Possibility of improving market conditions by introduction of standard fuel; properties of principal mixtures under consideration, with particular regard to by-products of coal distillation and alcohol-gasoline mixtures.

BALANCING MACHINES

RAPID. Schnellauswuchtmaschinen, B. Naberg. Werkstattstechnik v 26 n 8 Apr 15 1932 p 161–3. Design and operating principles of rapid balancing machines for crankshafts, rotors, etc. built by Trebel-Werk in Duesseldorf.

STATIC. Statical Balancing Machine, E. H. Lamb. Engineering v 133 n 3463 May 27 1932 p 641–3. Home-made machine developed for balancing small steam turbine; plan adopted was to make up form of compound pendulum upon which each disk could in turn be mounted so that it could be rotated into any desired position about its axis, which should remain fixed in pendulum.

BEARING METALS

GRAPHITE ADDITION. Graphited Bearing Metals Tested for Industrial Bearings, W. P. Eppers. Mar News v 18 n 12 May 1932 p 82–3 and 5. Results obtainable with graphited bearing: low bearing temperature, reduced friction conditions, minimum oil loss, high dependability, good operation after oil supply failures, great wear resistance, long life, reduced loss of hp.

LEAD-BASE. Ueber die leichtschmelzenden Schwermetalle in Blei-Lagermetallen, K. L. Ackermann. Metallwirtschaft v 11 n 21 May 20 1932 p 292–3. Readily melting heavy metals in lead bearing metals; investigation of influence of small admixtures of tin, thallium, bismuth, mercury and cadmium on strength of lead bearing.

BEARINGS, BALL

LUBRICATION. How Much Lubricant for Ball Bearing? P. J. Anderson. Maintenance Eng.

v 90 n 4 Apr 1932 p 170–1. Importance of proper amount of lubricant; curves illustrating consequences of improper lubrication.

SLIDING MECHANISMS. Ball and Roller Bearings for Sliding Mechanisms. Engineer v 153 n 3985 May 27 1932 p 592. Device which employs sun and planet principle, developed by Hoffmann Manufacturing Co.; in invention in its simplest form, load of sliding member can be carried by large ball; application so that use can be made of roller instead of ball for supporting sliding member involves slightly more complication.

STAINLESS-STEEL. Versuche mit Kugellagern aus nicht rostendem Stahl, W. Heinen. Chemische Fabrik v 5 n 18 May 4 1932 p 140–2. Tests with ball bearings of stainless steel; as result of tests, lubricating problem of these bearings is explained; care should be taken that rust from other machine parts does not settle on bearings; stainless-steel bearings are somewhat softer than standard ball bearings and have less bearing capacity; conditions under which they are applicable.

BEARINGS, JOURNAL

LUBRICATION. Experimentalle Untersuchung der Grenzbedingungen Fluessiger Reibung im oszillierend belasteten Gleitlager, P. Hein. Petroleum v 28 n 19 May 11 1932 p 1–14. Experimental investigation of boundary conditions of fluid friction in journal bearings under oscillating load; it is shown that pure hydrodynamic friction is possible also in bearings under oscillating load and in most cases is relatively easy to attain.

Film Lubrication of Journal Bearing, R. O. Boswall and J. C. Brierley. Instn Mech Engrs—Advance Paper mtg Apr 22 1932 95 p. Fundamental principles governing operation of clearance and bedded brasses and experimental determination of operating conditions for clearance brasses. Bibliography.

Mechanism of Lubrication, W. F. Parish and L. Cammen. Am Soc Mech Engrs—Advance Paper mtg June 1 1932 21 p 11 supp plates. Distinction between complete or film lubrication and boundary lubrication; what was hitherto referred to as oiliness can be measured by Cammen number representing bond by which Coulomb law and Langmuir layers are held on to metal and by total amount of adsorbed oil (Parish layer); new Sperry-Cammen tester described.

STRESSES. Oberflaechenspannungen und Ermuedungsbruch bei Waelzlagern, R. Mundt. Forschung auf dem Gebiete des Ingenieurwesens v 3 n 3 May/June 1932 p 127–34. Surface tensions and fatigue fracture in anti-friction bearings; phenomena occurring with fatigue of metals and appearance of damaged washer surfaces lead to conclusion that it is not normal but tangential pressure loads which influence fatigue; equations developed for calculating three main stresses in center of pressure surface of ball bearings; application to roller bearings. Bibliography.

BOILERS

CONTROL. Hochdruckkesseln, G. Wuensch. Waerme v 55 n 20 May 14 1932 p 321–3. Control of high-pressure boilers; development and prospects; problems of pressure control; operating experiences with high-pressure boiler control, with special regard to flexibility, storage capacity, and running time; feedwater regulation.

CORROSION PREVENTION. Electrical Methods Proposed of Preventing Scale and Corrosion in Steam Boilers, W. L. DeBaufre. Combustion v 3 n 11 May 1932 p 21–9. Theories and principles involved in numerous methods proposed for electrical prevention of scale and corrosion are explained and operation of some of principal methods described; methods and results of investigations.

DESIGN. Boiler Design Achievement in Space Utilization. Power v 75 n 22 May 31 1932 p 802–5. From start to finish Hudson Avenue station uses four boilers to serve each turbine unit; column spacing of boiler room fixes this requirement and allows no more floor space for later boilers serving 45,000 kw each than for original boilers serving 12,500 kw each; design and constructional details; elevation and cross-section of new bent-tube multidrum Combustion Engineering boilers.

ELECTRIC. Die Betriebsverluste der Elektrodendampfkessel, H. Eickemeyer. VDI Zeit v 76 n 17 Apr 23 1932 p 407–12. Operating losses in electrode-heated steam boilers, i.e., fundamental principles and cause of losses; efficiency and its twofold relationship to pressure; losses from removal of sludge and salt; losses from regulation; operating results.

FEEDWATER TREATMENT. Placing pH in Corrosion and Water Treatment, S. E. Tray. Power Plant Eng v 36 n 12 June 15 1932 p 487–9. Consideration of characteristics of industrial feedwaters; corrosion may take place in absence of oxygen if pH value is low; importance of oxygen may be overestimated; foaming and priming; ultimate aim of feedwater treatment.

SOLUBILITY OF STUDIES OF BOILER WATER, F. G. Straub. Combustion v 3 n 10 Apr 1932 p 12–16. Approximately 2000 separated solubility tests have been made in investigation being carried on at Engineering Experiment Station, University of Illinois, to determine solubility data at higher temperatures and pressures which data are to be used in ascertaining causes of scale formation and methods of prevention; testing equipment, methods and results.

FURNACES. Some Notes on Performance of Boiler Furnaces, A. T. Brown. Combustion v 3 n 10 Apr 1932 p 38–42. Empirical method for determining furnace outlet temperatures based principally on number of temperature measurements made on several installations; co-efficient of heat resistance used is limited to those types of waterwalls and furnace designs on which readings were taken; heat adsorption in water-cooled furnaces. Before Am Soc Mech Engrs.

Water-Cooled Furnaces for Underfeed Stokers, O. de Lorenzi. Combustion v 3 n 11 May 1932 p 15–20. As development of water cooling of furnace walls proceeded, possibilities of application to stoker-fired furnaces were realized and many installations were made; general review of design and constructional features of water-cooled furnaces employing underfeed stokers.

HIGH-PRESSURE. Stoomketels met ribbenbuizen systeem R-L, F. Muller. Ingenieur v 47 n 18 Apr 29 1932 p W59–66. Ribbed water-tube boilers of R-L system of Société Anonyme Delaunay-Belleville de St.-Denis; performance curves; boiler is suitable for very high pressure and specially designed to obtain high degree of evaporization.

Untersuchungen ueber den natuerlichen Wasserumlauf in Sulzer-Hoechstdruckkesseln. Feuerungstechnik v 20 n 5 May 15 1932 p 65–8. Investigations of natural water circulation in Sulzer super-pressure boilers; graphic method of Sulzer firm for determination of circulating conditions of water with all water-tube boilers.

PULVERIZED - COAL. Anpassungsvermoegen von Hochleistungskesseln, insbesondere Kohlenstaubkesseln an Mindestlasten, W. Grossmann. Waerme 4 55 n 21 May 21 1932 p 349–51. Adaptability of high-capacity boilers, especially pulverized-coal boilers, to minimum loads; flexibility of boiler for low partial load is dependent upon fuel; it is claimed tests are required to supplement results hitherto obtained; means of overcoming injurious effects of low loads.

Die Waermeuebertragung in der Kohlenstaubfeuerung mit all seitig gekuehltem Feuerraum, W. Gumz. Feuerungstechnik v 20 n 4 Apr 15 1932 p 50–3. Heat transfer in pulverized-coal furnace with walls cooled on all sides; heat emission of flame with water-cooled walls; method of determining gas temperature at end of combustion chamber; influence of air temperature, excess air, specific load, and dimension of combustion chamber; future prospects of pulverized-coal firing.

VIBRATIONS. Resonanztoene in Dampfkesselfeuerungen, F. Michel. Archiv fuer Waermewirtschaft v 13 n 5 May 1932 p 126–9. Resonance noises in boiler furnaces; pulsating of boilers and industrial furnaces; explanation of sound excitation; calculation of boiler hum before and after reconstruction; oscillation of thermometer cases and weirs, whistling in pipe lines, etc.

WASTE-HEAT. Waste-Heat Boiler Design, G. E. Hider. Instn Mech Engrs—Proc v 121 1931 p 533–43. Heat content of gases; total heat transfer; superheater; boiler tubes and rate of gas flow; analysis of steam costs on waste-heat boiler.

WATER-TUBE. Die Bedeutung der Wasserumlaufrechnung bei Dampfkesseln, M. Bluemel. Zeit des Bayerischen Revisions-Vereins v 36 n 9 May 15 1932 p 109–10. Calculation of water circulation in boilers; review of recent theories of water circulation, with aid of which large number of boiler damages can be explained.

YARROW. Boilers at Helsingfors Power Station. Engineer v 153 n 3981 and 3982 Apr 29 1932 p 482–3 and May 6 p 499–500. Main features of boilers supplied by Yarrow each has four transverse drums, and furnace volume of 2473 cu ft; all boiler tubes are straight; results of tests; efficiency trials; steam-raising tests; fuel consumption at no load; shut-down losses.

BORING MACHINES

BORING AND FACING CYLINDERS. Large Work Handled Economically by Special Cylinder Boring and Facing Machine. Iron Age v 129 n 22 June 2 1932 p 1212–13. Machine built by William Sellers & Co, for National Transit Pump & Machine Co, Oil City, Pa; used to bore and face at one setting cylinders and guides of large engine and booster pump units; believed to be largest of its type in United States, being suitable for cylinders of almost any kind.

BRAKES

INDUSTRIAL MACHINERY. Industrial Brakes Have Wide Variety of Uses, H. M. French. Mill and Factory v 10 n 5 May 1932 p 37–40 and 68. Review of construction and operating details of brakes employed on larry cars, skip hoists, conveyors, cranes, and hoists; characteristics of braking equipment to control doors in new Goodyear Zeppelin Airship Factory and Dock at Akron, Ohio.

BRASS

PROPERTIES. Free-cutting Brasses. Machy (Lond) v 40 n 1022 May 12 1932 p 169–71. Composition and physical properties of nickel, silicon, and plain free-cutting brasses; stress-strain curves and relation between temperature and hardness.

BRASS FOUNDRIES

MATERIALS HANDLING IN. Materials Handling in Small Brass Foundry, D. G. Anderson and B. F. McAuley. Am Foundrymen's Assn—Advance Paper n 32–10 mtg May 2–5 1932 12 p; see also Foundry Trade J v 46 n 821 May 12 1932 p 289–90. Sand-handling and sand-conditioning equipment of Hawthorne works of Western Electric Co.; methods of pouring and handling molds, and cleaning arrangements; results have been such as to justify methods installed.

CABLEWAYS

FRANCE. Personen- und Lastenfoerderung beim Kraftwerkbau im Hochgebirge, L. Stelling. VDI Zeit v 76 n 19 May 7 1932 p 463–6. Description of system of cableways and cable cranes for transportation of passengers and machinery, used in construction of Tramezaygues and Lassoula hydroelectric power plants; in French Pyrenees; capacity of cable cranes is 12 tons; cableways overcome differences in elevation of 768 m and 761 m in distances of 624 m and 657 m respectively.

CARS, PASSENGER

AIR CONDITIONING. Air Conditioning of Passenger Equipment, L. F. Bourgarde. Ice and Refrig v 82 n 6 June 1932 p 401–5. Economic advantages of air conditioning for passenger trains; development of York individual-car all-electric system for passenger-car service, using Freon as refrigerant; requirements for successful system. Before Eastern Car Foremen's Assn.

CASE-HARDENING

MILD STEEL. Quelques expériences sur la cémentation des aciers doux, J. Seigle. Revue de l'Industrie Minérale n 271 Apr 1 1932 p 131–6. Experiences in cementation of mild steel, with special reference to possibility of hardening solely with alkaline carbonates, without carbon, carbon monoxide or cyanide; penetration of pearlite in mass of metal.

CAST IRON

DEFORMATION. Mechanism of Deformations in Gray Iron, J. W. Bolton. Am Soc Testing Matls—Advance Paper n 35 mtg June 20–24 1932 11 p. Phenomena of "permanent set" are due to overstressing of certain portions of matrix, stress distribution is non-uniform; case is shown where "set" increases proportionally more than does increase in loading; room-temperature creep tests indicate that gray irons do not creep at room temperature when loaded to 80 per cent of their tensile strengths.

NITRIDED. Some Experiments on Nitrogen-Hardening of Cast Iron, J. E. Hurst. Engineering v 133 n 3460 May 6 1932 p 555–6. Experimental results form part of investigation of degree of hardness obtainable and general strength properties of aluminum-chromium cast iron suitable for nitrogen hardening; composition of alloy cast iron is within requirements of commercial product known as nitricastion. Before Iron and Steel Inst.

PROPERTIES. Production and Properties of Superior Cast Iron, O. Smalley. Metal Progress v 21 n 5 May 1932 p 49–54. Comparison of characteristics of cast iron made according to Meehanite process with physical properties of common castings; possibilities of controlling structure by heat treatment.

STRENGTH. Effect of Section on Tensile Strength of Gray Iron, F. P. Gilligan and J. J. Curran. Iron Age v 129 n 20 May 19 1932 p 1106–7 and 1125. Investigation of large cylinders which failed in service led to conclusion that strength of castings of different thicknesses follows fairly definite law and effect of composition is greatly minimized as section increases; test bars do not afford reliable basis for judgment;

probable strength range for all compositions in heavy sections in chart.

TESTING. Modern Practice in Cast-Iron Testing, H. W. Swift. Foundry Trade J v 46 n 813 and 814 Mar 17 1932 p 173–5 and Mar 24 p 187–90. Comparison of British, American, German, and French standard tests; sketches illustrate design and dimensions of specimens; choice of testing methods; problem of making proper allowance for "mass effect;" sampling method. Before Inst. Brit Foundrymen.

CHROMIUM-NICKEL ALLOYS

HEAT-RESISTANT. Heat Resistant Nickel-Chromium Alloys, W. Herrmann. Metallurgist (Supp to Engineer) May 27 1932 p 76–9. Binary nickel-chromium alloys are recommended for purposes requiring high resistance toward elevated temperatures, exceptional corrosion resistance and favorable electric resistance properties; metals used as deoxidizing agents; nickel-chromium-iron alloys; table of most important special alloys in this group. Bibliography.

COMBUSTION

AUTOMATIC CONTROL. Automatic Combustion Control Extended to New Section. Power v 75 n 22 May 31 1932 p 809–10. Details of new control system extended to new section of Hudson Avenue power plant; new-section regulation tied with old; master control panel; hand regulation of draft fans; control of hydraulic stoker motors.

CONVEYORS

BELT. Ergebnisse von Betriebs- und Laboratoriumsversuchen an Gurtfoerderbaendern, H. Haertig. Braunkohle v 31 n 15 Apr 9 1932 p 245–53. Results of plant and laboratory tests of belt conveyors; measurements of pulling force; tensile elongation and strength measurements; test results.

CUTTING TOOLS

CHROMIUM PLATING. Chromium Plating Cutting Tools Multiplies Their Wear-Life and Saves Many Man-Hours, J. Geschelin. Automotive Industries v 66 n 21 May 21 1932 p 748–51. Advantageous application of chromium-plated tools in various plants; principal causes of wear resistance of chromium plate.

TUNGSTEN CARBIDE. Application of Carbide-Alloy Tools to Turret Lathes, G. M. Class. Machy (NY) v 38 n 9 May 1932 p 671–2. Investigation to determine whether modern turret lathes meet requirements of tungsten-carbide cutting alloys; results of tests on Gisholt turret lathe.

Carbide Milling Profitable in Both Long and Short-Run Work, F. W. Curtis. Iron Age v 129 n 19 May 12 1932 p 1060–3. Advantages of cemented-carbide milling, including longer life between grinds and more output; outstanding foe of tungsten carbide is vibration; factors contributing to combined rigidity needed for tungsten-carbide milling machine fixture and cutter; tool cost per piece should not be determining factor. Before Am Soc Mech Engrs.

Present Status of Cemented-Carbide Tools, M. F. Judkins. Machy (NY) v 38 n 9 May 1932 p 643–9. Application of new cemented-carbide tools to modern shop practice; method of grinding cemented-tungsten turning tool tips to break up chips; results obtained in machining various metals with "Firthite" cemented-carbide tools; data on typical milling operations performed with cemented-carbide tipped cutters.

DIE CASTINGS

ZINC-BASE. Makes Die Castings at High Pressures With Low Melting Temperature, F. L. Prentiss. Iron Age v 129 n 23 June 9 1932 p 1246–7. Forcing metal into die-casting molds at high pressure and maintaining uniform and low melting temperature are among practices followed by Schultz Die Casting Co, Toledo, in manufacture of zinc-base die castings.

DIES

BENDING. Forming Compound Bends in Progressive Die. Machy (Lond) v 40 n 1022 May 12 1932 p 166–7. Layout of die for piercing, blanking, and forming of parts before being severed from strip; die composed of separate station units, one of which is collapsible to prevent locking of formed part in die.

DIESEL ENGINES

CYLINDER LININGS. Cylinder Liner Wear, J. H. Harrison. Engineer v 153 n 3984 May 20 1932 p 563–5. Attempt is made to collect information concerning liner wear and to examine theories propounded to explain cause; endeavor made to indicate lines along which research should proceed in order that cause may be ascertained and best means of preventing it discovered. Before Diesel Engine Users Assn.

DAIMLER-BENZ. Daimler-Benz Precombustion Chamber Engine, W. V. Dorrer. Motive Power v 3 n 4 Apr 1932 p 10–12 and 33. Design, construction and operating details of high-speed light-weight Diesel engine employing precombustion chamber; section through precombustion chamber showing manner of fuel injection; chart showing comparison of thermodynamic efficiency between gasoline and Diesel engines; longitudinal and cross-sectional diagrams.

DORMAN. Dorman-Ricardo Heavy-Oil Engine. Gas and Oil Power v 27 n 320 May 5 1932 p 104–5. Adoption of Ricardo air-cell-type cylinder head has enabled W. H. Dorman & Co to obtain useful power increase from their oil engine with reduction in fuel consumption; longitudinal and transverse section through Dorman Ricardo oil engine, showing air cell and other features.

ESTEP. Estep Develops New Diesel Engine. Motorship v 17 n 5 May 1932 p 195–7. Opposed-piston 2-stroke engine installed on tug "Leonie," rated 75 bhp at 400 rpm, is 3-cyl, 400-lb compression engine, having bore of 6 in., with combined stroke of 14 in.; cold-starting type, with common-rail airless fuel injection.

HUMIDITY EFFECT. Effect of Atmospheric Moisture on Diesel Engine Performance, H. A. Everett. Mar Eng & Shipg Age v 37 n 5 May 1932 p 198–201. Engine used in tests was 4-cyl, 4-cycle, 5-in. bore by 7-in. stroke, airless-injection precombustion chamber type, vertical Diesel engine, rated at 35 hp at 800 rpm.

MAYBACH. New Maybach High-Speed Diesel, E. P. A. Heinze. Diesel Power v 10 n 5 May 1932 p 203–5. Design and constructional details of two new types of engines of solid-injection type recently announced by Maybach Motor Mfg Co. of Friedrichshafen, Germany; speed-power output; table of engine specifications and performance.

DROP FORGING

MACHINING ALLOWANCES. Bearbeitungs-Zugaben und Schmiede-Toleranzen feur Freiform-Schmiedestuecke, F. Schildberger. Maschinenbau v 11 n 7 and 9 Apr 7 1932 p 149–52 and May 5 p 193–5. Determination of machining allowances and forging tolerances based on tests carried out by A. Borsig, Berlin-Tegel; use of alignment charts for pistons and rings.

ECONOMIZERS

EXPLOSIONS. Ueber Verhuetung von Explosionen an Rauchgas-Speisewasservorwaermern, M. Tohrlach. Feuerungstechnik v 20 n 4 Apr 15 1932 54–6. Prevention of explosion in economizers; defects in design of economizers which lead to explosions.

EVAPORATORS

MAINTENANCE. Operating and Maintenance Pointers on Evaporators, H. M. Spring. Power v 75 n 23 June 7 1932 p 843. Practical review of maintenance operations of high-pressure evaporators as employed for make-up in central stations and for process steam in industrial plants.

FANS

INDUCED-DRAFT. 16,000 HP. To Drive Induced-Draft Fans. Power v 75 n 22 May 31 1932 p 810–11. Consideration of factors determining size and power requirements of forced and induced-draft fans; operating characteristics.

FITS AND TOLERANCES

STANDARDIZATION. Tolerances for Large Diameters, N. N. Sawin. Am Mach v 76 n 18 May 5 1932 p 577–80. Recommendations on tolerances for large diameters and bores with data on results of experiments carried out in different shops for purpose of determining precision of fits; chart shows arrangement of work and customers' inspection gage tolerances (fixed and micrometric snap gages) for ISA Class 8, and diameters of 80 to 3000 mm.

FLOW OF FLUIDS

BOUNDARY LAYER. Note on Turbulent Boundary Layer, K. Wada. Soc Nav Architects Japan—Advance Paper 1932 8 p. Coefficient of mechanical viscosity in turbulent motion of fluid is put proportional to product of distance from boundary and mean velocity of fluid over it; velocity distribution in turbulent boundary layer and coefficient of frictional drag of smooth flat plate have been obtained. (In English.)

TURBULENT FLOW. Examination of Turbulent Flow With an Ultramicroscope, A. Fage and H. C. H. Townend. Roy Soc—Proc Series A v 135 n A 828 Apr 1 1932 p 656–77 and (discussion) 678–84. Ultramicroscopic examination of moving fluid carried out in Aerodynamics Department of National Physical Laboratory; minute particles present in tap water were intensely illuminated and viewed against dark background; most observations taken in square 0.89 in. by 0.89 in. pipe; fluctuations as high as 20 per cent of mean rate of flow occurred on axis, contrary to von Karman's theory.

FOUNDRY PRACTICE

CENTRIFUGAL CASTING. Effect of Centrifugal Casting on Grain Size of Metals, J. E. Hurst. Metal Industry (Lond.) v 40 n 18 Apr 29 1932 p 467–9. General experience confirms belief that one of effects of centrifugally casting metals and alloys is to produce finer grain structure in casting; behavior of non-ferrous metals; aluminum bronzes; analysis of high carbon content.

GAS TURBINES

USE WITH STEAM TURBINE. Internal-Combustion Turbine. Engineering v 133 n 3461 May 13 1932 p 575–6. Difficulties involved in development of gas turbine; many drawbacks have led to suggestion that it should be used in combination with steam turbine; in variant being experimented with by Brown, Boveri and Co., advantage is taken of fact that gases are discharged from explosion chamber at high pressure, to reduce size and cost of boiler required for given outputs.

GEARS

ELLIPTICAL. Elliptical Gears, H. J. Watson. Mech World v 91 n 2368 May 20 1932 p 487–8. Constantly changing linear velocity of teeth in elliptical gearing makes them peculiarly liable to chatter, due to slight variations in torque or inertia; practical solution which insures satisfactory results.

NON-METALLIC. Elasticity of Phenolic Laminated Gears Offers Advantages in Timing-Train, C. W. Mansur and H. M. Richardson. Automotive Industries v 66 n 17 Apr 23 1932 p 624–9. Design and application of non-metallic gears of phenolic laminated type; tests to determine their structural and wearing qualities; lightness brings moment of inertia of camshaft system to minimum, and high elasticity allows deflection with minimum stress.

SPUR. Spur Gears for Variable Center Distances, W. A. Tuplin. Machy (Lond) v 40 n 1019 Apr 21 1932 p 73–7. Formulas and charts for designing pair of equal gears to work at given minimum center distance and to give maximum possible extension of center distance; diagram showing relation center distance and backlash; variation of center distance of helical gears.

HARDNESS

RESISTANCE TO ABRASION. Resistance to Abrasion in Relation to Hardness, S. A. Main. Instn Mech Engrs—Proc v 121 1931 p 523–32. It is claimed that there is a great deal of research still to be done in studying resistance to abrasion; hardness, whether initial hardness of material or acquired in service, is not complete key to resistance to abrasion.

HEAT

CONDUCTION AND CONVECTION. Theory of Heat Conduction and Convection From Low Hot Vertical Plate, W. S. Kimball and W. J. King. Lond. Edinburgh and Dublin Philosophical Mag and J Science v 13 n 87 May 1932 p 888–906. Mathematical theory; heat transfer by radiation not considered; it is hoped that exhaustive treatment of this simplest case will open way for adequate theory of heat transfer from more complicated structures.

NEW HEAT UNIT. K-U-H, G. W. Cooper. West Gas v 8 n 6 June 1932 p 18–20 and 42. Suggestion is offered to gas industry in particular, and engineering world in general; new unit of heat measure to replace obsolete and cumbersome Btu; KUH would equal kwhr; table of conversion factors; conversion charts.

HEAT INSULATION

ALUMINUM FOIL FOR. Aluminum Foil—Heat Insulator for Power Plant Equipment. Power v 75 n 20 May 17 1932 p 717–18. When properly installed, aluminum foil offers high resistance to heat transfer, is light and unaffected by moisture; review of properties illustrated by curves.

HEAT TRANSMISSION

VISCOUS FLUIDS IN TUBES. Ueber den Waermeaustausch bei der Stroemung zaeher Fluessigkeiten in Rohren, M. Jakob and H. Eck. Forschung auf dem Gebiete des Ingenieurwesens v 3 n 3 May/June 1932 p 121–6. Heat exchange in flow of viscous fluids in tubes; results obtained by Holden and White on heat transmission with flow of oil in heated tube are compared with theory of Graetz; values obtained for temperatures and heat volumes can be explained only by combined effect of heat conduction and radial equalizing flow due to difference in viscosity.

HYDRAULIC TURBINES

CAVITATION. Korrosion durch Kavitation in einem Diffusor, H. Schroeter. VDI Zeit v 76 n 21 May 21 1932 p 511–12. Report on preliminary experiments made at Kaiser Wilhelm Institute for Hydrodynamics at Goettingen; observations on progress of cavitation in diffusor lined with gray cast iron, zinc, or bakelite C.

TESTING. Tests Conducted at Big Creek No. 1 With Experimental Nozzle and Needle Parts at Penstock Pressures, J. F. Davenport. Elec West (Committee Reports Number) v 68 n 6 May 15 1932 p 378–9. Report of subcommittee on current practice and research; Hydraulic Power Committee of Pacific Coast Elec. Assn.; test results tabulated in tables; sketch of typical experimental needle and nozzle design.

INDUSTRIAL MANAGEMENT

APPLICATIONS. Ueber Sparwirtschaft in Maschinenfabrik, R. Koch. Werkzeugmaschine v 36 n 8 Apr 30 1932 p 137–40. Example of application of principles of rationalization in plant for manufacture of machinery with particular regard to handling materials, wages, amortization of capital, rate of production, etc and their relation to price of product.

BUDGET CONTROL. How to Obtain Variability in Expense Budgets, F. V. Gardener. Iron Age v 129 n 23 June 9 1932 p 1243–5 and (adv sec) p 18. Variability can be obtained by segregating fixed and variable elements of cost and determining rate at which variable expenditures increase or decrease as manufacturing operations expand or contract; how successful flexible budget can be set up.

This Company Outsmarted Depression With Budget Control, J. P. Rogers. Factory and Indus Mgmt v 83 n 5 May 1932 p 183–5 and 211. Outline of control system employed by United States Radio and Television Corp. flexible budget report; review of accounting system together with general plant operations.

COST ACCOUNTING—FOUNDRIES. Sliding Scale for Oncost Charges in Foundries, H. Jordan. Foundry Trade J v 46 n 819 Apr 28 1932 p 267. System of dealing with overhead costs; in sliding-scale system overhead costs are distributed over working hours, but account is taken of fact that all charges are not directly proportional to time taken; they are regarded as coming under three categories: fixed charges, those dependent upon wages, and those dependent upon weight.

FATIGUE. Einfluss der Ermuedung auf die Strebleistung, R. Keller. Glueckauf v 68 n 18 Apr 30 1932 p 415–6. Influence of fatigue on productivity of miners; curve showing relation of effort to working time; basic forms of fatigue curves according to Mosso.

PRODUCTION CONTROL. Comment s'assurer les advantages de la production en série dans les petites usines, W. Clark. Manutention Moderne v 7 n 4 Apr 1932 p 11–13. General outline of principles of production control in small plants, manufacturing articles in series; advantages obtainable.

Successful Planning for Non-Repetitive Manufacture, C. B. Lord. Am Mach v 76 n 21 May 26 1932 p 661–5. Production control system developed by Harrison Works of Worthington Pump Co.; planning and recording of shop operations and despatching of materials.

We Call Cutting Time Idle Time, F. J. Van Propelen. Factory and Indus Mgmt v 83 n 5 May 1932 p 193–5. Changes in design of machines, manufacturers desire to reduce labor costs and understanding by workmen of problems confronting management have resulted in two or more machines operated by single workman; part played by time study in machine shop efficiency.

PROFIT MANAGEMENT. How Much Profit Must You Make?—I and II, C. E. Knoeppel. Factory and Indus Mgmt v 83 n 4 and 5 Apr 1932 p 143–5 and May p 209–11. Apr: Consideration of adequate and regular profits, and unification, of elements in profit-making; fundamental conclusions in profit-making; charts illustrating gage of annual profits. May: Technicalities of profit-making; consideration of profit and turn-over laws.

RUSSIA. Industrial Management Problems in Russia, W. N. Polakov. Paper Trade J v 94 n 20 May 19 1932 p 33–6. Review of progress made since 1920; industrial problems of Soviet; shop discipline; provision for coordination; elaborate organizations of trade unions; social insurance. Before Tech Assn Pulp and Paper Industry.

TIME STUDY. Die Betriebsumstellung einer kleineren Metallwarenfabrik auf Grund von Refa-Zeitstudien A. Winkel. Maschinenbau v 11 n 8 Apr 21 1932 p 161–3. Improvements in organization of production of small metal-working plants on basis of Refa time study; floor plan illustrates layout of presses and flow of materials.

INDUSTRIAL PLANTS

LOCATION. What to Consider Before Relocating Plant, R. M. Fischer. Iron Age v 129 n 18 May 5, 1932 p 1007–9 and (adv. sec) 24. Reasons for industrial migration; relocation of plant involves many risks and uncertainties and should not be undertaken without careful analysis of advantages and disadvantages; outline of logical and comprehensive procedure to follow in making relocation study.

INTERNAL-COMBUSTION ENGINES

CASTINGS. Production of Ferrous and Non-Ferrous Castings for High-Class Internal Combustion Engines, S. White. Foundry Trade J v 46 n 813 Mar 17 1932 p 176 and (discussion) 176 and 179. Suggestions for obtaining sound castings for cylinders, flywheels, etc; mixture used for bearings in gunmetal; cause of pinholes. Before Inst Brit Foundrymen.

DESIGN. Gleichfoermigkeit mehrzylindriger Verbrennungsmotoren, W. Kosney. VDI Zeit v 76 n 16 Apr 16 1932 p 380–2. New system of equations for calculating degree of uniformity of multi-cylinder engines; selection of number of cylinders for most economic uniformity on basis of graphs for different speeds and compression ratios.

SAFETY DEVICES. Automatic Safety Devices Protect Internal-Combustion Engines, W. M. Kauffman. Power v 75 n 21 May 24 1932 p 763–5. When emergency stops are made integral part of internal-combustion engines designed for automatic operation, engine builder assumes greater responsibility for unit's safe operation; methods employed and features of successful design.

[See also *Airplane Engines;* Automobile *Engines; Diesel Engines; Gas Turbines.*]

LOCOMOTIVES

CYLINDERS—WELDING. Welding Cast Iron Locomotive Cylinders, J. M. Vossler. Welding v 3 n 4 and 5 Apr 1932 p 217–19 and 225 and May p 290–2. Welding methods and equipment for repairing of cracked and broken locomotive cylinders with particular regard to design and erection of preheating furnace; precautions in cooling.

DIESEL-ELECTRIC. All-Welded Switching Locomotive, R. V. Devlin. Iron Age v 129 n 21 May 26 1932 p 1164. For switching service at Bush Terminal, New York, there was completed at Erie plant of General Electric Co seven 60-ton, 300-hp Diesel-electric locomotives; mechanical portion, including cab, underframe and trucks, is fabricated from structural steel shapes and plates, arc welded.

ELECTRIC-DESIGN. Pennsylvania Develops Three Types of Electric Locomotives, J. V. B. Duer. Ry Age v 92 n 21 May 21 1932 p 869–73. Motive power units can be used singly or in combination to provide power and speed requirements of all classes of trains; locomotive design, construction and operating details; speed-tractive-force curve of P5a locomotive; interchangeable parts simplify maintenance. Before Am Inst Elec Engrs.

TESTING. Testing 4-8-4 Type Locomotive on Lehigh Valley Railroad, R. P. Johnson. Baldwin Locomotives v 10 n 3 Jan 1932 p 50–7. Details of dimensional characteristics and design features incorporated in heavy-duty freight locomotive; features of testing equipment, methods and results of run between Buffalo and Jersey City.

LUBRICANTS

CUTTING. Cutting Lubricants and Soluble Oils, H. N. Bassett. Mech World v 91 n 2359 Mar 18 1932 p 276–7. Advantages possessed by fatty over mineral oils are largely offset by their considerably higher cost: efforts made to produce compound oils and emulsions in order to produce cheaper cutting lubricant; successful use of these liquids depends largely on maintaining their stability; desirable antiseptic properties.

LUBRICATING OILS

PROPERTIES. Ist der Viscositaetsverlust der Schmieroele bei der Verduennung ein Merkmal fuer die Schmierfaehigkeit? M. Roegiers. Angewandte Chemie v 45 n 18 Apr 30 1932 p 320–3. Investigation of whether viscosity loss of lubricating oils with thinning is indication of lubricating properties.

MACHINE DESIGN

STRESSES. Vorschlag zur Festlegung der zulaessigen Beanspruchungen im Maschinenbau, Fr. P. Fischer. VDI Zeit v 76 n 19 May 7 1932 p 449–55. Project for revision of allowable working stresses in design of machinery on basis of latest tests on strength of metals under repeated alternate stresses; diagrams of coefficients of fatigue strength of polished and non-polished metallic members under alternate bending, tension-compression and torsional stresses; advantages of high grade steels; safety factors.

MACHINE TOOLS

LEIPZIG FAIR. Machine Tools at Leipzig Fair. Engineering v 133 n 3454, 3455, 3456, 3457 and 3460 Mar 25 1932 p 370–1 and 374 Apr 1 p 397–8, Apr 8 p 426–9, Apr 15 p 452–5 and 460 and May 6 p 541–3. In view of economic conditions, attention is being directed to reduction of production times, improvement of manufacturing processes and full utilization of production capacity of machines; replacement of pneumatic by electric chucks; standardization of machine tools in Germany; self-contained unit system; removal of turnings and chips.

MODERN. Modern Machine-Tools, C. H. Russell. Instn Mech Engrs—Proc v 121 1931 p 573–87. Modern trends and improvements; special-purpose machines; center lathes and capstan and turret lathes; semi-automatic, milling and grinding machines.

TESTING. Inspection and Testing of Machine Tools, G. Schlesinger. Machy (Lond) v 40 n 1021 May 5 1932 p 145–8. Test charts for facing lathes and vertical boring mills with data on permissible errors and tolerances for principal parts of machines.

MALLEABLE IRON

CORROSION. Corrosion of Malleable Iron, F. L. Wolf and L. A. Meisse. Am Soc Testing Matls—Proc v 31 pt 2 1931 p 422–33 and (discussion) 434. Tests conducted at laboratories of Ohio Brass Co.; three types of çorrosion encountered; atmospheric corrosion in all conceivable locations; corrosion due to locomotive smoke and to acid mine water; materials tested.

FORGED AND ALLOY. Forged and Alloy Malleable Iron for Special Uses, F. B. Riggan. Mech World v 91 n 2367 May 13 1932 p 457–8. Forged malleable has relatively high physical properties, and is desirable for making intricate shapes and for castings in which one part must have high strength and another part must have ordinary characteristics of malleable iron; alloy malleable containing copper and molybdenum possesses superior anti-corrosive properties for certain uses.

METALS

DEFORMATION. La limite elastique des metaux, P. Vernotte. Chimie et Industrie v 27 n 4 Apr 1932 p 765–9. Elastic limit of metals; definition of term; fatigue of metals; nature of deformations; effects of high temperatures.

FATIGUE TESTING. Dauerbrueche und Dauerfestigkeit, R. Mailaender. Kruppsche Monatshefte v 13 Mar 1932 p 56–81. Principles of endurance testing on machines for alternating load developed by C. Schenck, Darmstadt; comparison of research results for principal metals with particular regard to relations between vibration strength and other physical properties, factors contributing to failures in machine parts subject to alternating stresses; influence of corrosion and temperature.

HIGH-TEMPERATURE MECHANICAL TESTING. Apparatus for Long Period Temperature—Stress Tests on Metals, W. H. Hatfield, G. Stanfield, J. Woolman and N. B. McGregor. J Sci Instruments v 9 n 5 May 1932 p 150–3. Apparatus for high-temperature mechanical testing for accurate determination of "creep" and allied effects, includes sensitive extensometer and method for close control of temperature of specimen heated in resistance furnace; method makes use of platinum-resistance coil placed in furnace which forms part of Wheatstone bridge.

NOTCHED-BAR TESTING. Bending Tests on Geometrically Similar Notched Bar Specimens, J. G. Docherty. Engineering v 133 n 3464 June 3 1932 p 645–7. Investigation of dimensional effect by carrying out tests on specimens of various sizes, but geometrically similar to standard specimen; rate of bending; effect of size of specimen; suggested relation between energy absorbed and size of specimen; empirical relations; analyses of experimental results and conclusions.

Résistance des aciers aux chocs répétés, L. Grenet. Aciers Spéciaux Métaux et Alliages v 7 n 79 Mar 1932 p 82–92. Investigation of resistance of different types of steel to repeated shocks with particular regard to effects of heat treatment and carburizing.

Notched Bar Impact Testing, P. F. Foster. Machy (Lond) v 40 n 1020 Apr 28 1932 p 105–7. Procedure for making Izod and Charpy tests on Amsler machine; determination of energy absorption.

TESTING. Test Results and Service Values of Materials, H. F. Moore. Heat Treating and

Forging v 18 n 4 Apr 1932 p 245–7. Determination of significance of test results; interpretation of accelerated test; correlation of test results with particular regard to impact and tensile tests. Before Am Soc Testing Matls and Am Inst Min and Met Engrs.

WEAR. Relative Wear of Metals Due to Abrasion, C. R. Weiss. Iron Age v 129 n 21 May 26 1932 p 1166–7 and 1180. In order to ascertain material best suited to insure maximum wear value at minimum cost for power-chain purposes, Link-Belt Co. developed apparatus described; low-carbon steel was used as comparator material; comparative wear values of several metals are reported. Before Am Foundrymen's Assn.

MILLING MACHINES

CUTTERS. Determining Value of Tungsten-Carbide Milling Cutters—I, B. P. Graves. Machy (N. Y.) v 38 n 9 May 1932 p 650–3. Tests conducted at Brown & Sharpe Mfg. Cos. plant, in milling cast iron for purpose of ascertaining factors underlying successful application of tungsten carbide to milling operations, indicate that probable speed to be used with tungsten-carbide tipped cutters milling cast iron is approximately 200 to 235 ft per min.

Economic Factors Affecting Use of Carbide-Tipped Milling Cutters, M. Romaine. Machy (N. Y.) v 38 n 9 May 1932 p 665–9. Applications of tungsten- and tantalum-carbide for blades of milling cutters; possibility of using higher speeds and feeds, increased tool life, and cutting of hitherto unmachineable materials; milling operations performed on cylinder blocks and heads of 12-cyl motor.

VERTICAL TYPE. Vertical Miller With Traveling Planer-Type Housing. Iron Age v 129 n 23 June 9 1932 p 1257- and (adv sec) p 20. Spindle machine that is departure from usual types placed on market by Sleeper & Hartley, Worcester, Mass.; table is stationary and housing, with its rail and spindle head, travels on flat ways located at each side of bed.

NITRIDATION

NITRIDING STEELS—PROPERTIES. Nitride Hardening. Machy (Lond.) v 40 n 1021 May 5 1932 p 137–9. Physical properties and composition of principal types of nitriding steels; surface hardness of 1000 to 1200 Vickers-Brinell; resistance of nitriding surfaces to corrosion and abrasion.

SPECIAL ALLOY STEELS. Surface Hardening by Nitrogen of Special Aluminium-Chromium-Molybdenum Steels on Production Basis, W. H. Cunningham and J. S. Ashbury. Iron and Steel Inst—J v 124 n 2 1931 p 215–28 and (discussion) 229–39. Process of nitriding as carried out productively by firm with which authors are connected; treatment of articles; methods of protection against hardening; growth of parts; distortion; hardness testing; surface defects; heat treatment; furnace routine.

THEORY AND PRACTICE. Theory and Practice of Nitrogen Case-Hardening, A. Fry. Engineering v 133 n 3461 May 13 1932 p 587–8. With view to gaining closer insight into nature of hardening effect, tentative experiments were carried out bearing upon formation and decomposition of nitrides of such elements as influence behavior of nitriding steel under treatment; chemical affinity of nitrogen for elements investigated; experiments serve to explain mechanism of nitrogen case-hardening process when applied to commercial nitriding steels. Before Iron and Steel Inst.

PLASTICS

DIE CASTING. Die Verarbeitung plastischer Massen im Spritzgussverfanren, H. Stadlinger. Chemiker-Ztg v 56 n 42 and 44 May 25 1932 p 409–11 and June 1 p 431–2. Molding of plastic bodies according to die-casting process; examples of die-casting machines and products obtained by process; advantages of process.

MOLDING. Hydraulic Molding Press. Engineering v 133 n 3464 June 3 1932 p 668–9. Quick-acting press with heated platens for molding materials of bakelite type, manufactured by Hahn and Kolb, Stuttgart; frame is of built-up welded construction; ingenious pumping system supplies low-pressure fluid for bringing ram up to work and high-pressure fluid for actual molding operation.

PUMPS

CENTRIFUGAL—DESIGN. Aus dem Kreiselpumpenbau, W. Siebrecht. VDI Zeit v 76 n 16 Apr 16 1932 p 377–80. Application of research results in modern design with diagrammatic representation of output, speed, etc. for different types of rotors.

CENTRIFUGAL—FEEDWATER. Neuerungen in Hochdruck-Kesselspeisepumpen, E. Vogel. Elektrotechnik und Maschinenbau v 50 n 18 May 1 1932 p 273–6. Design and performance characteristics of large multi-stage feedwater pumps with particular regard to problems of high pressure and temperature.

CENTRIFUGAL—VISCOUS LIQUIDS. Das Verhalten von Kreiselpumpen bei Foerderung sehr zaeher Fluessigkeiten, K. Gruen. Foerdertechnik und Frachtverkehr v 25 n 7/8 Apr 8 1932 p 75–9. Behavior of centrifugal pumps in displacement of liquids of high degree of viscosity; losses may be calculated from efficiency and throttling curves obtained for water.

CONTROL. Preliminary Report on Surge Suppressor Control in Pump Discharge Lines, R. S. Quick. Elec West (Committee Reports Number) v 68 n 6 May 15 1932 p 379–82. Report of current practice and research subcommittee, Hydraulic Power Committee of Pacific Coast Elec Assn; preliminary report covers novel means of limiting pressure rise in pump-discharge line, produced by unstable flow immediately following power interruption to prime mover of pump.

GAS-DISPLACEMENT. Christie Two-Stroke Gas Displacement Pump. Engineer v 153 n 3983 May 13 1932 p 536–7. Pump patented by S. P. Christie and built to his order by Marcus Hodges and Sons; principle upon which it operates is that devised by H. A. Humphrey, but with difference that two-stroke cycle is used in place of four.

RAIL MOTOR CARS

DIESEL-ELECTRIC. High-Speed Oil-Electric Rail Coach. Engineering v 133 n 3461 May 13 1932 p 582. Car built by German State Railways for service between Berlin and Hamburg; driven by two Maybach airless-injection engines located on each of end trucks; 12-cyl models, developing 410 bhp at 1400 rpm, each direct coupled to generator; since designed speed is 93 mph, air resistance was of primary importance and model tests were carried out in wind tunnel of Zeppelin works at Friedrichshafen to determine most suitable form for car bodies.

GASOLINE. La modernisation des chemins de fer vicinaux Belges, F. Bordas. Industrie des Voies Ferrées et des Transports Automobiles v 26 n 304 Apr 1932 p 103–5. Notes on recent modernization of interurban railroads in Belgium; gasoline-operated rail motor cars with rubber tires, by Société Nationale des Chemins de fer Vicinaux de Belgique, for 30 passengers, illustrated and described; data on motor bus operation by same company.

REFRIGERATING MACHINES

ABSORPTION. Durch Waerme betriebene kompressorlose Kuehlmaschinen, E. Rausch. Waerme v 55 n 18 Apr 30 1932 p 290–1. Heat-actuated compressorless refrigerating machines; conversion of heat into cold; ammonia absorption machines; sulphurous-acid adsorption machines; energy consumption; utilization of waste heat of steam power plants for production of low temperature.

DESIGN. Air-cooled Diffusion Refrigerating Machine, G. Maiuri. Cold Storage v 35 n 409 Apr 21 1932 p 87–8. Details of diffusion machine, principal characteristic and advantage of which is production of refrigeration at various temperatures in same circuit; diagrammatical view of air-cooled diffusion refrigerating machine with new type of boiler; thermodynamic considerations; table of tests.

RIVETED JOINTS

CRACK DETECTION. Rivet Hole Failures. Engineer v 153 n 3982 May 6 1932 p 509. Instrument especially designed for investigation of interior condition of rivet holes which may be suspected of being source of failure on account of incipient crack; it is virtually inverted periscope with enlarging lens.

TESTING. Versuche mit Nietverbindungen bei oftmals wiederholter Belastung, O. Graf. VDI Zeit v 76 n 18 Apr 30 1932 p 438–42. Report on tests, made at Stuttgart Institute of Technology, of riveted joints subjected to frequently repeated stresses; fatigue strength of structural steels; slip resistance in riveted joints; deformation and failure of riveted joints due to frequently repeated stresses; usefulness of fatigue strength in riveted joints.

ROLLING MILLS

ROLL PRACTICE. Graphische Ermittlung und Nachpruefung von Vor- und Streckkaliber-Reihen, O. Emicke. Stahl und Eisen v 52 n 21 May 26 1932 p 505–9 and (discussion) 509–11. Graphic determination and testing of shaping-groove and straight-pass series, based on practical examples of ingot-steel rolling; new rules and equations; graphic method can also be applied to change from one pass series to another.

SHEET MILLS. Reduces Cost of Handling Sheets. Iron Age v 129 n 22 June 2 1932 p 108–9. Practice of E. C. Budd Mfg. Co., Philadelphia, in handling of sheets from steel mills to first manufacturing operation; large saving effected through use of gondola cars has to do with problems of bracing and of loading and unloading.

Vergleichende Zeitstudien in Feinblech-Walzwerken zur Ermittlung von Sortenkosten, H. Jordan. Stahl und Eisen v 52 n 19 May 12 1932 p 461–5. Comparative time studies in sheet mills for determination of costs according to dimensions; so-called time keys for allotment of operating costs; uniform time records obtained in new sheet mill; evaluation in form of rolling programs; influences of rolling processes; cooling times; relation between weight of sheet, piece and ton rate.

What Happens When Rolling Thin Sheets, W. H. Melaney. Blast Furnace and Steel Plant v 20 n 4 Apr 1932 p 335–7. Lubrication of sheets; old-time method; tension on sheet; roughing sheets; pinched sheet; theoretically proper shape; steam on center; modern method of using steam; breakage of rolls.

SCREWS

MANUFACTURE. Accurate Dies Required for Rolled Threads, H. L. Simonds. Iron Age v 129 n 19 May 12 1932 p 1058–9 and (adv sec) 20. Large part of material used in production of machine and cap screws at plant of Scovill Manufacturing Co., Waterbury, Conn., is brass and copper produced in Company's own near-by mills; making rolled-thread screws; screw department produces 26,000 different styles and sizes of screws with total production reaching hundreds of millions yearly.

SPEED REDUCERS

DESIGN. High Speed Gear Units for Speed Increase or Speed Reduction, P. C. Day. Diesel Power v 10 n 4 Apr 1932 p 166–8. Use of high-speed gear units for speed increase or reduction permits use of Diesel engines for driving efficient, high-speed centrifugal pumps and other high-speed equipment of similar characteristics; similarity between speed increase or reduction units; fundamental problems of design and use involved in selection and application of this type of gearing.

NOISE MEASUREMENT. Noise Specifications for Large Reduction Gears in Terms of Physical Units, E. J. Abbott. Acoustical Soc Am—J v 3 n 4 Apr 1932 p 445–82. Series of measurements made of sounds produced by certain type of large reduction-gear unit for determining noise specifications for that particular type of machine; project was sponsored and supported by Detroit Edison Co. Bibliography.

SPRINGS

DESIGN. Cylindrical Springs of Variable Pitch, J. J. Pesqueira. Gen Elec Rev v 35 n 5 May 1932 p 271–4. Theoretical mathematical design analysis and exemplification.

SPIRAL. Springs for Maximum Effort, J. Jennings. Mech World v 91 n 2364 Apr 22 1932 p 390–1. To put spring into given space and obtain maximum effort throughout working range is problem solved; method eliminates frequently wasteful trial-and-error method.

STEAM

HIGH-PRESSURE. La valeur économique des hautes pressions de vapeur dans les centrales a condensation et a contre-pression, A. De Smaele. Conférence Internationale des Grands Réseaux Eléctriques a Haute Tension—Compte Rendu des Travaux de la Sixiéme Session 18–27 Juin 1931 v 1 p 75–101 and (discussion) 115–18. Report No. 35 at 1931 Session of International High Tension Network Conference in Paris; economic value and production of high pressure in steam-electric power plants, employing condensation or back pressure; conclusions.

TABLES—COMPARISON OF. Comparison of Recent Steam Tables, P. A. Willis, G. A. Hawkins and A. A. Potter. Power v 75 n 23 June 7 1932 p 841–3. Need for new steam tables; work on steam tables in United States and in Europe; comparison of recent tables for saturated steam and for superheated steam.

STEAM ACCUMULATORS

APPLICATIONS. Problem of Fluctuating Steam Demand. Chem Age v 26 n 674 May 28 1932 p 483–5. Information supplied by Ruths International Accumulators, Ltd., London; problem of fluctuating demand for steam and economic results to be attained by installation of steam storage system; it is of particular interest to works engaged in textile dyeing, soap manufacture, food processing and other industries where steam is used mainly for boiling or cooking operations.

STEAM CONDENSERS

LARGE. World's Largest Condensers 0.63 Sq Ft Per Kilowatt. Power v 75 n 22 May 31 1932 p 822–7. Each of single-pass condensers serving 160,000-kw turbines in Hudson Avenue station contain same tube surface, 101,000 sq ft; materially different in arrangements for steam distribution and water circulation; design and constructional details; circulating-water distribution.

PERFORMANCE. Condensers and Auxiliaries. Elec West (Committee Reports Number) v 68 n 6 May 15 1932 p 439–45. Report of subcommittee on condensers and auxiliaries, Prime Movers Committee of Pac Coast Elec Assn; detailed report by D. P. Woolley of Southern California Edison Co. on subject of condenser performance; graphic condenser records for two 100,000 kv turbines are shown together with methods of obtaining results.

STEAM PIPE LINES

EXPANSION. Contribution à l'étude de l'aptitude élastique des Tuyauteries de vapeur au point de vue dilatation, H. Carlier. Chaleur et Industrie v 13 n 143 Mar 1932 p 235–42. Mathematical study of elastic properties of steam pipe lines with particular regard to expansion; calculation of stresses and displacement for different types of bends.

INSULATION. Vorteile fuer die Isoliertechnik bei Anwendung der Schweisstechnik im Rohrleitungsbau, P. Eising. Schmelzschweissung v 11 n 4 Apr 1932 p 66–9. Reduction of heat losses and savings in insulating materials effected by use of welded construction.

STEAM POWER PLANTS

DESIGN. Providing Reliability in 770,000-Kw. Station, J. F. Fairman and C. M. Gilt. Elec World v 99 n 21 May 21 1932 p 894–900. Installation of two 160,000-kw units in space originally planned for 50,000-kw units has just completed Hudson Ave. generation station of Brooklyn Edison Co.; station contains total rating nearly twice that originally planned, and two last units have more than three times rating of original units, yet expansion program was readily permitted by initial plans.

FRANCE. L'usine Arrighi (nouvelle usine génératrice de Vity-Sud(de l'union d'Electricité, L. Vellard. Revue General de L'Electricite v 31 n 18 and 19 Apr 30 1932 p 597–609 and May 7 p 611–54. New Arrighi steam-electric power plant of l'Union d'Electricite in Vitry-Sud; ultimate capacity 500,000 kw; installed capacity 225,000 kw in three units of 75 kw each; steam pressure 39 kg per sq cm at 450 C; detailed illustrated description of plant and equipment.

GREAT BRITAIN. Extensions to Hackney Generating Station. Engineering v 133 n 3463 May 27 1932 p 635–7; see also Engineer v 153 n 3985 May 27 1932 p 578–82. Station has been extended by addition of three 125,000-lb boilers, 30,000-kw turbo-generator and necessary auxiliary plant; it is one of those selected under South-East England scheme and is scheduled to generate 51,000,000 kw-hr with max load of 31,000 kw during present year.

PERFORMANCE TESTING. Built-in Test Facilities Give Check on Performance, W. F. Davidson. Power v 75 n 22 May 31 1932 p 828–30. During design and purchase of equipment of Hudson Avenue station, Brooklyn, methods of test were carefully considered, resulting in provisions for testing turbines on regenerative cycle, determination of condenser cleanliness factor and special arrangements for determining flue-gas dust loading and analysis.

POWER AND PROCESS. Turbine Arrangements for Supplying Industrial Power, W. B. Flanders. Power v 75 n 23 June 7 1932 p 847–9. Economic possibilities of local generation of power when large quantities of low-pressure steam are required for process have been stressed; effect of turbine efficiency on byproduct power generation and discussion of various turbine arrangements.

SUPERHEATED-STEAM COOLING. Die Heissdampfkuehlung und ihre Apparate, B. Mueller. Waerme v 55 n 20 May 14 1932 p 331–5. Superheated-steam cooling and apparatus employed; advantages of use of steam coolers and examples of various applications.

STEAM TURBINES

DESIGN. Problems of Turbine Design, C. R. Soderberg. Elec World v 99 n 18 Apr 30 1932 p 772–7. Unless user of equipment is acquainted with major problems of design to meet performance specifications, he is liable to feel, at times that manufacturer is inherently opposed to development, or he may write specifications that handicap best design; analysis of problems confronting turbine builders tends to overcome both, and indicate probabilities of meeting future requirements.

TANDEM UNITS. Two Tandem Units Add 320,000 Kw. to Station Capacity. Power v 75 n 22 May 31 1932 p 814–19. New turbines at Hudson Avenue are largest tandem units in operation and are coupl.d to largest generators yet built; units generate 40 kw per sq ft of turbine-room floor area and are installed in space originally planned for 50,000-kw unit; cross-section of high- and low-pressure cylinders; curves show comparison of heat rate guaranteed and that obtained on test.

VIBRATION. Vibrations of Group of Turbine Blades, K. Sezawa. Soc Nav Architects Japan—Advance Paper 1932 10 p. Effect of deck band on natural frequency of blades in group which are mounted on rim of turbine wheel rotating with constant speed; method of combination of two kinds of frequencies, one of which is that for elastic body without rotation, and other, that for same body when effect of flexural rigidity is neglected. (In English.)

STEEL

ALLOY. See *Alloy Steels*.

COLD WORKING. Ueber den Einfluss des Anlassens auf die mechanischen und magnetischen Eigenschaften kaltgezogenen Stahles, W. Koester and H. Tiemann. Archiv fuer das Eisenhuettenwesen v 5 n 11 May 1932 p 579–86. Influence of tempering on mechanical and magnetic properties and on electric conductivity of cold-drawn steel; change of tensile strength, elastic yield, elongation and contraction, coercive force, resonance and electric conductivity of annealed steel and wire by tempering at various temperatures after cold drawing.

PROPERTIES. Sensitivity of Steel and Modern Ideas of Quality, H. W. Graham. Iron Age v 129 n 22 June 2 1932 p 1211 and (adv. sec) p 20. Problem of steel quality as it confronts metallurgist; variations of steel quality are inadequately explained by chemical analysis of common elements; term sensitivity is suggested to refer to characteristics of steel by virtue of which it responds in varying degree to external conditions. Before Am Iron and Steel Inst.

TOOL. See *Tool Steel*.

STEEL CASTINGS

STRENGTH. Einfluss des Gluehens auf die Drehschwingungsfestigkeit von Stahlguss, B. Garre and E. Grathoff. Stahl und Eisen v 52 n 20 May 19 1932 p 493. Influence of annealing on torsional strength of steel castings; results of experimental investigations at strength testing laboratory of Danzig Institute of Technology.

TEMPERATURE EFFECT. Festigkeitseigenschaften von Stahlguss bei tiefen Temperaturen, R. Walle. Stahl und Eisen v 52 n 20 May 19 1932 p 489–90. Strength of steel castings at low temperatures; yield limit, tensile strength expansion, shrinkage, Brinell hardness, and notch toughness of two specimens of steel castings at temperature as low as —80 C.

Strength of Cast Steel at High Temperatures, K. H. Mueller and E. Piwowarsky. Foundry Trade J v 46 n 822 May 19 1932 p 307. Report of tests on specially cast specimens from room temperature up to 500 C; tensile and creep strengths and hardness were only slightly raised by increasing carbon and by addition of manganese, but more so by use of chromium, especially with tungsten or nickel.

STOKERS

OPERATION. Efficient Operating and Banking Methods With Overfeed Stokers, H. M. Spring. Power v 75 n 20 May 17 1932 p 719. Practical review of proper operating methods of front-feed and side-feed opposed-stoker types of overfeed stokers; banking procedure.

TRAVELING-GRATE. Die Durchzuendung beim Wanderrost, P. Rosin and E. Rammler. Archiv fuer Waermewirtschaft v 13 n 5 May 1932 p 113–17 Ignition of fuel layer as important problem in combustion on traveling-grate stokers; agreement between theory and experimental results; practical conclusions; means of accelerating ignition.

UNDERFEED. Burning Bituminous Coal on Underfeed Stokers, B. Houghton. Power Plant Eng v 36 n 10 May 15 1932 p 415–16. Larger-size units bring about new problems of operation which must be met and solved if high efficiency and reliability are to be maintained; chart showing how combustion progresses; test curves used in determining maximum steaming capacity. Before Third Int Conference Bituminous Coal.

Width Limitation Leads to World's Longest Underfeed Stokers. Power v 75 n 22 May 31 1932 p 806–8. Space limitations were primary factor in molding design of stokers in Hudson Avenue station, resulting in longest underfeed stokers yet built; extensions to coal- and ash-handling systems; cross-section of Taylor underfeed stokers installed under boilers serving units No. 7 and 8; world's largest underfeed stokers.

TEMPERATURE-MEASURING INSTRUMENTS

VACUUM CALORIMETER. Vacuum Calorimeter for High Temperatures, L. G. Carpenter and T. F. Harle. Phys Soc—Proc v 44 pt 3 n 243 May 1 1932 p 383–99 and (discussion) 399. Form of platinum-thermometer type of vacuum calorimeter has been developed which is suitable for determination of true specific heats at high temperatures, since it is constructed without any organic insulating materials; design is novel in that heat is transferred from platinum coil to calorimeter by radiation.

TESTING MACHINES

CALIBRATION. Full-Load Calibration of 600,000-Lb Testing Machine, H. F. Moore, J. C. Othus, and G. N. Krouse. Am Soc Testing Matls—Advance Paper n 88 mtg. June 20–24 1932 5 p. Calibration of screw-power, balance beam-testing machine; calibration made by use of two 10,000-lb standard weights and elastic bar fitted with delicate strainometer; after 27 years of rather severe service, testing machine was found to still have high degree of accuracy and sensitivity.

TOOL STEEL

MOLYBDENUM-TUNGSTEN. New Tool Steel Contains Molybdenum and Tungsten. Iron Age v 129 n 23 June 9 1932 p 1252–3. Cutting steel in which molybdenum replaces tungsten to considerable extent, but which in its finished form is similar in properties to more common high-speed steels, developed by Universal Steel Co., in collaboration with Cyclops Steel Co., designated as Mo Tung heavy-duty cutting steel; it is said to be more economical to produce than tungsten high-speed steel and somewhat lighter.

WAGES

WAGE-PAYMENT PLANS. If Fixed Salaries Were Not Fixed, P. W. Schubert. Factory and Indus Mgmt v 83 n 5 May 1932 p 198–9. Outline of author's proposed wage payment plan for dividing burdens of depression and profit of good times more equitably; curves and tables illustrating plan.

WELDING

STRUCTURAL STEEL. Standardization of Technique in Metallic Arc Welding, A. R. Moon. Engineering v 133 n 3462 May 20 1932 p 589–93. It is claimed slow progress in use of welding is mainly due to lack of recognized standards of quality, workmanship and performance; quotations from draft code of regulations dealing with arc welding in steel structures by Standards Association of Australia, as appendix to S.A.A. Code for Steel-Framed Structures; examples of work recently completed in Victoria.

WELDS

CORROSION. Device Perfected for Studying Corrosion of Welds. Iron Age v 129 n 23 June 9 1932 p 1253. Corrosion in welded boilers, pipes, and containers, for oil and chemicals, is being studied in research laboratories of Westinghouse Electric & Mfg. Co., East Pittsburgh, with special apparatus in order that engineers may know how to fabricate structures so that all parts will be uniformly resistant to rust.

TESTING. Experimental Work on Welds. Engineer v 153 n 3983 May 13 1932 p 527–8. Review of technical report for 1930–31 of British Engine Boiler, and Electrical Insurance Co., recording experimental investigations of satisfactory or unsatisfactory nature of welds; detection of defects in welded joints; welds broken in tension; resistance to shock; overhead and vertical welding; contour of fillet welds; welded monel metal; atomic hydrogen process.

X-RAY ANALYSIS. Vereinfachung von roentgentechnischen Grobstrukturuntersuchungen durch praktische Hilfsmittel, W. Grimm and F. Wulff. Autogene Metallbearbeitung v 25 n 5 Mar 1 1932 p 65–75. Simplified practice and equipment for X-ray inspection of macrostructure; precautions in taking photographic records with particular regard to use of lead shields and windows.

WOODWORKING MACHINERY

MULTIPLE PRODUCTION WITH. Multiple Production Possibilities—I, II, and III, J. E. Hyler. Wood-Worker v 51 n 1, 2, and 3, Mar 1932 p 27–8, Apr p 33–4 and May p 36–8. Review of facts which illustrate growth of multiple principle in woodworking field; additional types of machines which are used in multiple work; possibilities of multiple production on molder, mortiser, tenoner, dove-tailing machine, and automatic turning lathe, and suggestions for applying idea to these machines.